THE DENTAL PRACTITIONER

and

DENTAL RECORD

Including the official reports of the British Society of Periodontology, the British Society for the Study of Orthodontics, the European Orthodontic Society, the Liverpool and District Odontological Society, the North Staffordshire Society of Dental Surgeons, the Odonto-chirurgical Society of Scotland, and the Dental and Medical Society for the Study of Hypnosis

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VOL. VI, No. 2 October, 1955

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THE DENTAL PRACTITIONER
AND DENTAL RECORD

Vol. VI, No. 2 October, 1955

EDITORIAL

THE WINTER MONTHS

WHEN the clocks go back and the hours of darkness lengthen, the evening game of golf vanishes with the summer suns, and we are left to ponder over our books by the artificial light of a desk lamp. The summer months restore our physical well-being while the winter months refresh our mental processes. Society secretaries who have toiled throughout the summer to build the winter's programme now move into top gear as arrangements go forward to quench the thirst for knowledge of those who attend their meetings. It is not easy to cater for the taste of everybody and most of us have our individual interests and always like to hear our own views expressed by the lecturer. The once-monthly meeting is bound to be fairly open in its outlook and general in its appeal, but nevertheless is of great importance. To the men who wish to study one particular aspect more deeply there are many study circles and short courses arranged by the various dental societies and institutions. The prime object of this short post-graduate study is the dissemination of new knowledge. They are not just to keep the general practitioner *au fait* with anything new or to enable him to maintain his own individual standard. They are specifically designed to enable him to improve his standard. In the classic words of G. V. Black: "The professional man has no right to be other than a continuous student." A standard is the degree of excellence required for a particular purpose, and is something that serves as a basis of comparison. If meetings or study circles are never attended we have no means of knowing what our standard is, as the very definition of the word precludes our knowing. We must not fall into the trap of believing that our patients will set our standards. The standard of a patient is based largely on faith, while the standard of the professional man must be based on knowledge and experience. These two standards may be widely divergent. Patients essentially have treatment on trust and believe that it is performed with a reasonable degree of correctness and accuracy. They have faith in the dental surgeon in the same way that they have faith in their bank. Having virtually no knowledge of the intricacies of banking they expect and receive a completely honest account of their affairs. Patients should expect no more and no less from the dental surgeon, for they have placed their trust in him.

If our patients have faith in our treatment, and obviously the great majority have, it is up to us to ensure that their faith is not misplaced. The safest method of ensuring this is by maintaining a standard of dentistry which is impeccable. This can only be achieved by constantly furthering our knowledge and techniques through the interchange of knowledge with our colleagues.

MODERN METHODS IN PERIODONTAL TREATMENT

By **MAX WALTER**, D.M.D.

In order to understand and practise methods of treatment of periodontal disease it is essential to be aware of certain basic facts of the structures we are mainly concerned with. Once we have a clear understanding of the physiology and anatomical structure of the periodontal tissues, we can appreciate the pathology, and thus plan the treatment.

Gingival Tissue.—Differentiated as follows: (1) Free gingiva or marginal gingiva; (2) Attached gingiva; (3) Mobile alveolar mucosa.

1. *Free Gingiva or Marginal Gingiva.*—This surrounds the tooth, cufflike, but is not attached to the tooth. The space between free gingiva and the tooth surface is called the gingival sulcus; it is lined by stratified squamous epithelium. Normally the crevicular epithelium lines the free gingiva and lies in close contact with the enamel, to which it is attached by the epithelial attachment. This is the deepest point of the normal sulcus, and a very important landmark in considering periodontal problems.

The interproximal space between the teeth is filled by the interdental papilla, partly consisting of free gingiva and partly of attached gingiva.

Microscopically the free gingiva is held to the tooth by the free gingival fibres of the periodontal membrane. They radiate from it through connective tissue and terminate below the epithelium. This dense fibrous structure was formerly called the ligamentum circulare. These gingival fibres play an important part in the initial stage of periodontal disease. They keep the papilla closely adapted to the enamel surface and act as a barrier against downgrowth of epithelium.

2. *Normal Attached Gingiva.*—This is characterized by its stippled surface.

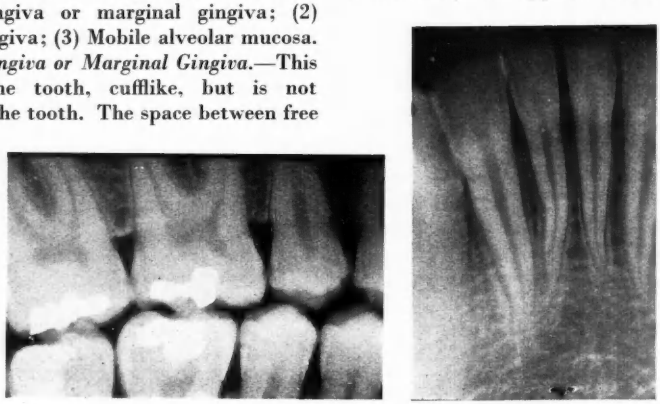

Fig. 1.—Radiograph of normal bone; dense layer of cortical bone, which protects the spongeosa beneath as a lid.

3. *Mobile Alveolar Mucosa.*—This represents the mucosal fold.

Periodontal Membrane.—The periodontal membrane consists of collagenous connective-tissue fibres, crossing in various directions and fixing the tooth to the alveolar bone. Some fibre bundles pass over the alveolar crest from one tooth to the other and are called transeptal fibres. They support the tooth in its vertical position. All periodontal fibres radiate from the bone into the cementum.

The periodontal membrane functions as a shock absorber. In advanced periodontal disease, periodontal fibres are lost, bone is resorbed, and tooth mobility increases. In treating periodontal disease our ultimate aim is to arrest it and to establish reattachment—

by which we understand a new formation of the peridontal membrane, new apposition of bone, and formation of cementoid.

Cementum.—Only certain important features are mentioned. Cementum is laid down continuously during life, and its primary function is to cover the dentine of the root,

Fig. 2.—Resorption of bone.

and to help to retain the tooth in its socket, by virtue of the attachment of the periodontal membrane. Its secondary function is to repair any damage caused to the root. Its width may be compared to the thickness of a human hair.

Alveolar Bone.—In a radiograph normal bone will show a dense layer of cortical bone protecting the spongeosa beneath, as a lid (*Fig.* 1). If this lid shows interruption, bone resorption has begun (*Fig.* 2). In areas of pressure the lamina dura appears denser than in areas of tension. Resorption can be seen on the pressure side, when teeth are in traumatic occlusion (*Fig.* 3). A tooth under function shows a regular trabecular meshwork, whilst a disused tooth gives a picture of diffuse, loose bone structure.

OBJECTS OF TREATMENT

Main Targets.—The main objective in treating periodontal disease is to maintain a normal healthy gingival sulcus. Patients should be taught the correct use of a toothbrush. Horizontal strokes are damaging to the gingival tissues. The Stillman or Charter technique is preferred to any others. The former consists of a sweeping and twisting motion, the latter is more concentrated in the interdental spaces by small circular movements. The palatal and lingual surfaces must not be neglected. Proper timing is essential;

Fig. 3.—Traumatic occlusion, widening of periodontal membrane $\underline{4}|$.

regular tooth and gum brushing removes plaques from the enamel surfaces, and keeps the free and attached gingiva stimulated and healthy. However, if hygiene is insufficient, plaques calcify and calculus accumulates at the gingival margin and in the sulcus.

Waerhaug (1952) found that calculus always harbours bacteria and that they thrive in and around it. As a result of this stagnation, the toxins so liberated cause the breakdown of the free gingival fibres. The papilla becomes swollen and is detached from the enamel surface, the epithelium is no longer closely adapted to the enamel, and the initial stage of a pocket is reached.

As the sulcus ulcerates there is a rapid downgrowth of epithelium along the cementum, thus deepening the pocket. The epithelial attachment moves in an apical direction and is stopped from further downgrowth by the next healthy periodontal fibre it meets. The new epithelial attachment now represents the deepest part of the pathological pocket; calculus grows down simultaneously. Waerhaug's exacting experiments show that the distance of the calculus from the epithelial attachment varies between 0·5 mm. and 2 mm. The deeper the calculus is deposited into the pocket, the smaller will be the distance between

the calculus and the base of the pocket. Deep calculus cannot always be felt clinically with instruments as it is very thin and flintlike in structure.

POCKETS

Types of Pockets.—There are three types of pockets: (1) Gingival, (2) Suprabony, (3) Infrabony.

1. The *gingival* pocket exists when the normal sulcus increases in depth and *does not* extend below the cemento-enamel junction, but shows an increase in gingival tissue towards the crown as in marginal gingivitis, as in incompletely erupted teeth, gingival hyperplasia, causing a false pocket. There is not yet bone destruction.

2. The *suprabony* pocket is a pathological pocket which extends beyond the cemento-enamel junction, but has not yet reached the level of the alveolar crest.

3. The *infrabony* pocket extends still deeper, below the level of the alveolar crest. The latter is found interproximally, on palatal aspects of lower molars. This infrabony pocket occurs at the side where bone is more dense.

Examination.—All pockets should be clinically examined, measured with a calibrated pocket probe, and recorded.

Usual radiographic examination cannot reveal the true depth of a pocket. To obtain a picture of such a pocket, it is necessary to introduce Hirschfeld's (1953) graduated silver points (*Figs.* 4–7).

Scaling.—Calculus is deposited in all three types of pockets, and its removal is of the greatest importance. A pocket cannot heal until all calculus is thoroughly and completely removed.

The smallest instruments only should be used. They are held lightly with the three-finger grasp. The fourth finger acts as a support either on the adjacent teeth, or on the lips or cheek. The scaler is introduced into the base of the pocket to engage the deepest calculus deposit, which is then removed by a short pull-stroke. Little discomfort is caused if this is done correctly. A double-ended explorer, such as that designed by Cross (1953), helps to detect calculus by the sense of touch.

A radiograph only guides us in disclosing deposits on a tooth interproximally, but not

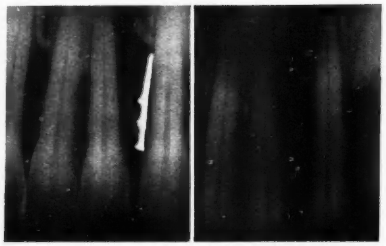

Fig. 4.—Infrabony pocket; Hirschfeld's graduated silver point in position 8 mm.

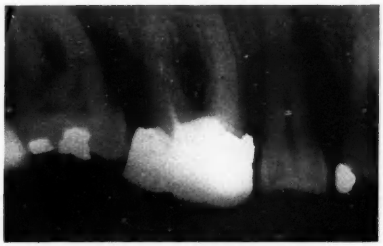

Fig. 5.—Infrabony pocket without Hirschfeld's silver point.

Fig. 6.—Same case, with silver point.

Fig. 7.—Infrabony pocket mesial of $\overline{7}$ with graduated silver point in position

buccally or lingually, and is therefore only of limited value in the diagnosis of calculus (*Fig.* 8). Pressure packs introduced prior to scaling are also helpful.

Subgingival Scaling.—Waerhaug (1954) has greatly disillusioned us by his histological investigations, in which he maintains that no scaler should be thicker than 0·6 mm. in order

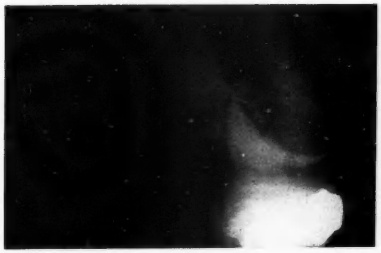

Fig. 8.—Radiographic appearance of calculus right upper molar. Spurs of calculus. Lower front teeth.

to reach the deepest deposits. None of the available scalers can be introduced into an interdental space down to the epithelial attachment.

Quite revolutionary instruments are now being designed, and made of tungsten-carbide steel. These instruments are small enough, and do not require continual sharpening.

Scaling instruments are available in the following types:—

1. Sickle scalers. Fine sickle scalers such as those designed by McCall serve for the removal of supragingival calculus.
2. Hoes.
3. Curettes.
4. Files, such as the Columbia University set (*Fig.* 9), copies of which are available in this country. They serve for the removal of subgingival calculus.

The curettes and files are designed to remove fine deposits, but it is preferable to use the curette. It has an elongated blade which ends with a rounded point. The cutting surfaces of the base are parallel, and its back is convex.

When they are narrow they can easily be introduced between tooth and soft tissues, and by a pull action scrape these deposits from the root surface. All these instruments must be resharpened after use. A sharp blade must bite into the fingernail when moved over it, otherwise it is useless. During scaling, the cemento-enamel junction must be treated gently, otherwise exposure of very sensitive dentine is caused. Files are used to smooth the root surface following the use of curettes.

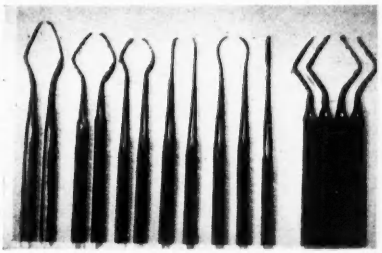

Fig. 9.—Columbia set of scalers, curettes, and files.

After scaling careful polishing of the tooth or root surface with fine abrasives and rubber cups is essential.

Subgingival Curettage.—Subgingival curettage is carried out with fine curettes and files. The object is to remove the contents, smooth the cementum, and to convert a pathological pocket into a healthy clean one. Subgingival curettage should be undertaken when the gingiva appears œdematous. By curetting a pocket, we try to reduce the state of inflammation. Healing should result in a reduction or

shrinkage of the pocket. In responsive cases reattachment may be achieved. Subgingival curettage is not indicated when the gingival tissues are taut, as they would neither shrink nor bleed. Bleeding is necessary to create a healthy blood-clot. Subgingival curettage proves to be successful in supra- and infra-bony pockets.

Technique of Subgingival Curettage.—It is not necessary to perform subgingival curettage under local anæsthetic in cases of suprabony pockets, as when carefully done no discomfort is felt by the patient. Cases of intrabony pockets, however, must be anæsthetized.

Step 1. The subgingival calculus is removed with curettes and the dead cementum scraped and the root surface smoothed, as only into newly deposited cementoid will Sharpey's fibres become reinserted.

Step 2. The pathological proliferated crevicular epithelium is curetted. Finger pressure against the outside of the pocket assists the curetting instruments and prevents perforating the buccal gingival pocket wall. When properly carried out, scraped epithelium which lined the pocket and granulation tissue will adhere to the curette blade. By curetting the soft-tissue wall of the pocket bleeding and the formation of a blood-clot is caused. The tip of the ulcerated papilla is then excised with the curette, preventing the epithelium from growing over too fast before the blood-clot is organized.

Step 3. Finally the removal of the epithelial attachment with an extra fine curette is essential. It automatically takes place when the curette reaches the deepest part of the pocket. If the epithelial attachment is not removed, no reattachment can occur. The curetted gingiva is gently pressed with finger pressure towards the tooth.

Step 4. A small piece of adhesive tinfoil is laid over the blood-clot to protect it from the pressure of the periodontal pack which is laid over the surface of the wound. This pack remains for one week to ten days. New periodontal fibres, bone, and cementum are laid down, thus resulting in reattachment. We can now assess whether gingivectomy is necessary or not.

Gingivectomy.—Gingivectomy is the method of choice either (1) when pockets persist after subgingival curettage, or (2) if the soft-tissue wall of the original pockets consist of taut fibrous tissues.

Gingivectomy eliminates surgically deep pockets and at the same time removes the epithelial attachment. The aim should be to create a new triangular cone-shaped interproximal papilla with sloping planes buccally and lingually. During the operation alveolar bone should not be removed unless it interferes with the creation of a bevelled gingival surface. Thorough scaling must always precede gingivectomy, to reduce the inflammatory condition.

Instruments.—

1. Two pairs of Blake knives with blades No. 15 and 11 (one for left and one for right).
2. Pocket markers, Crane-Kaplan type (Messrs. Down Bros.).
3. Small curettes and scalers.
4. Aspirator suction pump.
5. Fine gingival scissors.
6. Diamond stones for bevelling and contouring the operated gingiva.

Technique.—The mouth is divided into four quadrants, one quadrant at a time being operated on in order that the patient is not put to too much discomfort.

1. Anæsthesia is first given into the mucosal fold and then into the base of each papilla, buccally and lingually.

2. Depth of pockets are marked with the Crane-Kaplan marker, and then the bleeding points caused by its beak are a guide line for the initial incision. The pocket marker must always be inserted into the pocket by holding it parallel to the long axis of the tooth.

3. Using a No. 15 blade, the initial incision is made slightly beyond the marker point in a steep bevelled direction, to be sure of removing the epithelial attachment and the complete pocket. This incision is of the greatest importance, *and it is better to remove too much than too little of the gingival tissue.* The incision should be limited to areas within the attached gingiva. If it terminates in the mobile mucosal fold, the cut edge would curl back and normal healing as physiologic gingiva would not take place.

4. Following the first incision, with a No. 11 blade, the interproximal areas are severed from the buccal as well as from the lingual aspect, and the whole diseased gingiva is removed in one place. Tags must not be left.

5. Now follows the removal of granulation tissue, and calculus (which may have been left after preliminary scaling): As soon as the pathological gingival tissue, including the epithelial attachment, is removed, the granulation tissue is exposed. It is carefully curetted along the root surface, without injuring the bone. An aspirator is most useful, and together with saline irrigation helps to give a clear view of the interproximal spaces. Subgingival calculus can then easily be seen and be scaled. Granulation tissue at this state is pathological and infected and could never organize to mature tissue. Therefore, it must be removed. The ensuing blood-clot is then replaced by healthy granulation tissue, provided no trace of calculus is left, from which normal structures develop. The removal of granulation tissue without scaling of calculus at the same time is useless.

6. After bleeding has stopped, the periodontal pack is mixed and applied simultaneously from lingual and buccal aspect, with finger pressure. It is moulded around the teeth, and must be clear of any occlusal interference and not infringe on either the frœna or the muscular movements. The pack must be carefully and firmly interlocked between the interdental spaces. While the pack is hardening, seepage stops.

After a week or ten days epithelialization will have taken place, and the pack is then carefully removed. Healing proceeds and no further treatment is necessary. The patient is now instructed to perform good oral hygiene.

Some people favour electric surgery, but in my opinion it should not be used, as it interferes with fast and normal healing. It can become hazardous when the electrode touches bone accidentally, causing very painful necrosis.

As long as intrabony pockets are of the narrow type, they can be treated according to the principles of subgingival curettage. However, broad and winding intrabony pockets are operated by the flap method. By raising the flap the difficult topography of such a pocket can more easily be mastered and, after curetting, the flap is closed and sutured. Healing of intrabony pockets takes place in the same way as after root apicectomy. The relationship of tissues in apicectomy is: root surface, blood-clot, bone (Goldman, 1953; Glickman, 1953; Fish, 1948; Schaffer and Zander, 1953). Just the same happens after infrabony pocket curettage. When healed we find a new lamina dura. From the blood-clot which lies between root face and alveolar bone, new periodontal membrane fibres and cementum are laid down.

Pocket Extension into the Alveolar Mucosa.—There are occasions when a periodontal pocket is so deep that its base reaches beyond the attached gingiva—namely, into the mobile alveolar mucosa. In these cases the initial cut for gingivectomy lies in movable tissue, and the gingival margins cannot heal normally; therefore, in addition to the routine technique, the alveolar mucosa is cut in a horizontal direction and by blunt dissection pushed deeper down into the buccal fold. The surgical pack must be of much firmer consistency to hold the displaced alveolar mucosa in the new position. After healing a better physiologic condition results. The gingival margin cannot curl back, and the patient can use a toothbrush better than before, because the oral vestibulum is deepened. The same technique is applied when pockets are caused by the constant pull of frœna, often found in lower front teeth. The frœnum is severed by a wide horizontal cut and again the alveolar mucosa is pushed down, thus increasing the vestibulum in this area (Goldman, 1953).

After all these periodontal operations, a normal architecture of the gingiva should be aimed at. There should be no thickening or rounding of the papilla. The gingival margins must be well adapted to the tooth surface and terminate in a thin edge. This reshaping, contouring, and bevelling is achieved during the surgical part with either small diamond stones or by a scraping action of the gingivectomy knife. Wheel-shaped diamond stones, when carefully handled, easily groove and

festoon the tissue (similar to festooning of a plastic denture) so that after epithelialization normal anatomical surface structure, with vertical depressions between the protruding elevations of the roots, reappear. Goldman (1953) calls this procedure gingivoplasty.

Fig. 10.—Bifurcation involvement of lower molars.

Fig. 11.—Drifting of |7 into space of extracted |6; loss of contact point, with subsequent food impaction.

Fig. 12.—Drifting of 7| mesially; food impaction, pocket formation.

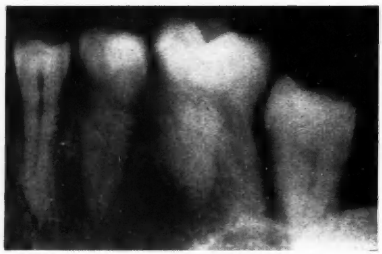

Fig. 13.—Elongation of 7|; food impaction.

After complete healing, the masticated food is sluiced over the newly shaped gingival surface, keeping it under normal massage and friction. If the rule of gingivoplasty is not observed, shelf-like gingival ledges remain, inviting food stagnation, inflammation, and relapse of pocket formation. Gingivoplasty re-establishes a self-cleansing gingival surface.

Bifurcation, etc., Involvement.—When pockets in the molar region involve interradicular areas, we speak either of bifurcation or of trifurcation involvement (*Fig.* 10). It is easily recognized radiographically. All granulation tissue between the roots are removed. The gingivectomy technique is the same as for single-rooted teeth. Patients are taught to clean bifurcation areas with pipe cleaners and operated teeth of this kind have a very good prognosis, although they originally appeared to be hopeless. Bifurcation involvement can be with bone loss on either the buccal or lingual alveola, or on both, then a blunt probe passes freely through. Although bone is often exposed during the operation, it is not removed unless sharp protruding ledges would prevent smooth healing. Every bit of bone is valuable and must be jealously guarded.

Periodontal Abscess Formation.—Bacteria are forced into the pockets during mastication. These bacteria are normally dealt with by the lymphatic system, i.e., they are carried away. Owing to the movement of the loose tooth, the bacteria can be compressed in a lymph-vessel and their movement arrested with resultant

stasis. The breakdown and liquefaction results in pus formation, which is walled off as an acute abscess.

Treatment.—First of all, the tooth must be taken out of occlusal stress. This is done by grinding the opponent tooth, and if possible the loose tooth. The abscess is incised to establish drainage. After the acute condition has subsided, the case is treated as already described under "gingivectomy", and curetted by the flap technique.

Periodontal treatment is not only confined to surgical measures; it must be co-ordinated with the problems of occlusal equilibration. Very often the supporting tissues break down when groups of teeth are exposed to occlusal trauma. If there is already a periodontal condition present, and at the same time occlusal imbalance, rapid destruction of the supporting structures takes place. Occlusal equilibration should only be done when a periodontal condition manifests itself. It must be thoroughly understood, because if not done according to rules, great harm may be caused to the patient. In order to maintain normal physiological conditions fixed or removable splints should be constructed. Crown and bridgework or partial denture designs should be carried out in such a way as not to provoke periodontal breakdown. Missing teeth must be replaced, the continuity of the dental arch maintained, and contact points and marginal ridges must be guarded and reproduced in restorations; cervical fillings must restore the buccal convexity of teeth, otherwise food impaction invites periodontal disease (*Figs.* 11–13). Extruded and elongated teeth have to be ground or extracted. Their premature contact during occlusion would separate sound teeth and also cause food impaction and periodontal destruction.

There are more teeth lost as a result of periodontal disease than through caries or other oral diseases. To prevent this, the general standard of conservative dentistry must be improved, together with good periodontal treatment.

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IDEAL DENTAL OCCLUSION IN THE PRIMATES*

By J. R. E. MILLS, M.Sc., F.D.S., D.Orth.

The Primates form one of the main orders of Mammals in the classification evolved by Linnæus, and since modified by other authors. This order is usually divided into two sub-orders, which Simpson (1945) calls the Anthropoidea and the Pro-Simii. The former comprises the New World monkeys, from Central and South America, the Old World monkeys, from Asia and Africa, and a third group which consists of the anthropoid apes and man himself. The other sub-order, the Pro-Simii, is less well known, but in many ways more interesting. It comprises the lemurs, lorises, and tarsiers, found in relatively limited areas of Asia and Africa, and notably in the island of Madagascar. Its most primitive member is a tree-shrew from the Malayan archipelago called *Tupaia*, which has a particularly interesting dentition, and to which I shall refer in some detail later.

The dentition of the primates is important for two reasons: Firstly, because it has remained remarkably generalized, with few

* Given at the Sheffield meeting of the British Society for the Study of Orthodontics, Friday, May 6, 1955.

of the specializations which tend to fog the picture in other orders, and secondly because it is the order to which we, ourselves, belong, and findings in the other Primates may, in some cases, be applicable to man.

Their dentition has been studied in detail by numerous authors. However, the non-human members of the order have been studied most by palaeontologists, in connexion with the study of comparable fossil material, and since the latter is usually fragmentary, relatively little attention has been paid to their occlusion, and practically none to their chewing mechanism.

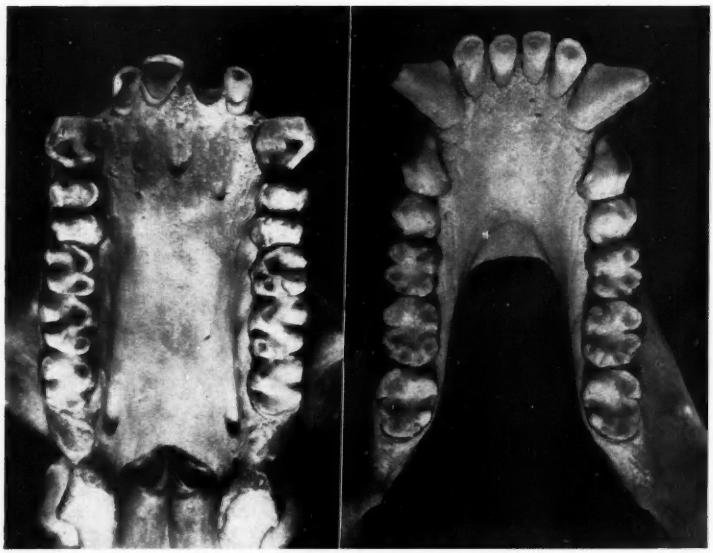

Fig. 1.—The upper and lower dental arches of *Gorilla.*

Cope (1889) and Gregory (1922, 1934, a) have produced occlusal diagrams to illustrate the relationships of the cusps in centric occlusion, while Ryder (1878), who was among the first to investigate this field, appreciated that the cusps of the lower molars, in the majority of mammals, slid between the corresponding cusps of the upper molars in that action which we usually call lateral excursion. Gregory (1920) showed this to be the case in the fossil lemurs *Notharctus* and *Adapis*, basing his findings on the evidence of the wear facets on the teeth. Butler (1952) has demonstrated a similar condition in the Perissodactyls, also using the wear facets to provide his evidence. The last author has shown this movement of the lower cusps between the corresponding upper ones, as the jaw slides from the lateral position to the centric one, and also, as the movement continues, that the lower buccal cusps come into contact with the upper lingual ones.

My attention was first directed to this dynamic occlusion of the teeth—that is, the movement of the teeth during chewing—on examining the skull of the gorilla. Since this was, in fact, the first to be examined, and since it shows a fairly typical picture, I propose to describe the condition in this specimen, and my methods of investigation, and then consider other genera in detail.

The dentition of the gorilla is shown in *Figs.* 1, 2. It is of all the primates the most like that of man. It has the same dental formula of $\frac{2.1.2.3}{2.1.2.3}$ and the general form of

the teeth is not unlike our own. The lower molars are all of the five-cusped pattern, while in the upper molars the distolingual cusp, or hypocone, is larger than in most modern human dentitions. The main difference between the two lies, however, in the canines, which are large and tusk-like in the male gorilla, and still enlarged, although to a lesser extent, in the female. As a result they project above the general level of the occlusal plane, and become interlocking. This fact has caused many comparative odontologists, including so great an authority as Keith (1913) to deny the possibility of any lateral excursion in the great apes, and to state that chewing takes place by a purely orthal, or vertical hinge-like action. Shaw (1917) has shown that such a mechanism would be very unsatisfactory, and that the most mechanically efficient method of comminuting the food is by means of a shearing action, in which one plane surface moves across another, remaining parallel, and in as close contact as possible throughout.

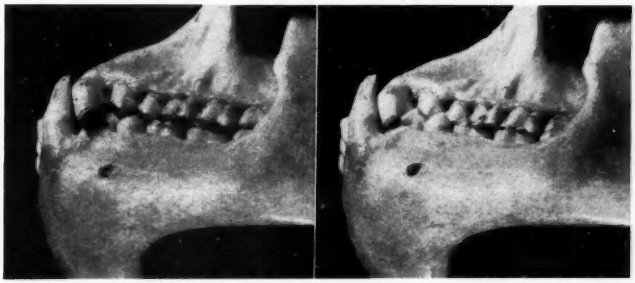

Fig. 2.—Lateral view of the dentition of *Gorilla*, (*left*) in centric occlusion, (*right*) at the end of lateral excursion.

In fact, as Gregory (1916) has pointed out, a wide degree of lateral slide is possible in the gorilla, but the effect of the large canines is to limit it to a single narrow path. This is shown in *Fig.* 2. On the left we see the cheek teeth in centric relation, with the uppers slightly overlapping the lowers, while on the right the lower molars have moved laterally. The upper canine slides between the lower canine and first premolar, while the lower canine slides between the upper lateral incisor and canine.

However, it is one thing to say that such a lateral slide is possible, and another to say that it does, in fact, take place. Some proof is necessary. As will be realized, it is difficult to obtain the co-operation of a live gorilla, but fortunately the chewing action leaves evidence behind it in the form of wear facets on the teeth. These facets appear, macroscopically, as flat, highly polished areas on the cusps of the molar teeth. They can be seen more readily under low-power magnification, if the specimen is slowly turned about until the light strikes it at a favourable angle.

Unfortunately, a difficulty was immediately encountered, although this later proved to exist only in the great apes, and to a lesser extent in the Old World monkeys. It was that, during wear of the teeth, the enamel of the molar crowns is very quickly worn through, and the dentine exposed. Once this has happened wear becomes more rapid, and the facet pattern is quickly destroyed. However, this was overcome by careful selection of specimens, one set, of juvenile individuals, being used to examine the first two molars, and another, of slightly older animals, for the second and third molars. By the time the third molar comes into occlusion, the first is usually extensively worn. Thus the diagram of facets shown in *Fig.* 3 is essentially a composite picture, with the second molar providing an overlap. In making this examination I was fortunate to have access to a large collection of skulls of Primates in the collection of the British Museum (Natural History).

Fig. 3 shows, then, the facets found on the upper and lower molars of the gorilla. It will be seen that on the upper molars there are three sets of facets. Two of these, shaded by means of continuous lines, face lingually, while the third, shaded by means of broken lines, or stippling, faces buccally. On the lower molars, on the other hand, the position is reversed; one set faces lingually and two buccally.

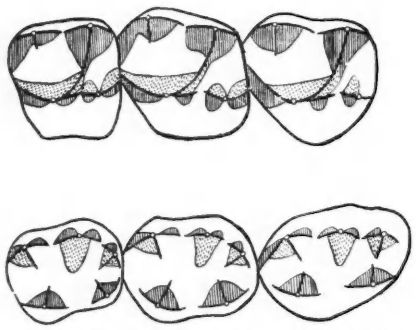

Fig. 3.—Plan view of the upper and lower molar teeth of *Gorilla*, showing the pattern of wear facets found on the teeth. The mesial is to the left of the diagram, and the buccal to the top.

Now, if we examine these facets under somewhat higher power, it will be seen that they are not as flat as would at first sight appear. They are, in fact, covered by fine scratch marks, produced by the coarser particles of food. Moreover, in any given facet, these scratch marks, or at least the overwhelming majority of them, are parallel and therefore serve to indicate the direction of jaw movement which produced the facet in question. In fact, the lines used in shading the facet areas in *Fig.* 3 follow approximately the direction of the scratch marks; those shown by continuous lines running directly transversely, and those shown by broken lines running at a slight angle. It is not, of course, possible to tell by this method whether the chewing motion was from buccal to lingual or vice versa, or, indeed, a mixture of the two.

Turning now to the manner in which these facets are produced, let us consider firstly those on the distobuccal cusp, or hypoconid, of the lower molar. It will be seen from *Fig.* 3 that there are three facets on this cusp; two facing buccally (indicated by continuous shading) and one lingually (stippled). In *Fig.* 4 B we see the second upper and lower molars superimposed in centric relation. It will be seen that in this position the hypoconid occludes in the central fossa of the upper molar. This, incidentally, is a primitive arrangement, which is remarkably constant throughout the Primates.

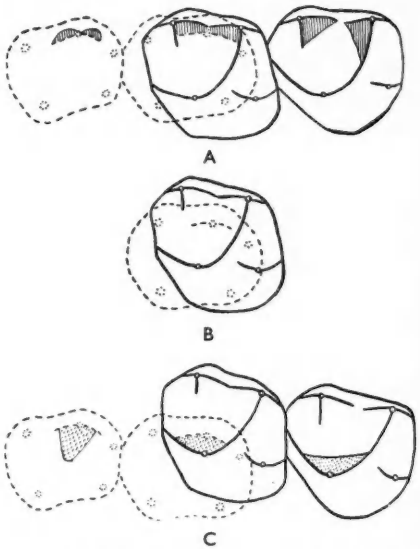

Fig. 4.—The upper and lower second molars of *Gorilla*, superimposed; A, During the buccal phase of occlusion, B, in centric occlusion, and C in the lingual phase. The shaded areas indicate the areas of shear between the hypoconid and neighbouring cusps. In A and C are also shown the lower first and upper third molars, to illustrate the facets which result therefrom. (Upper teeth shown by continuous, lower by broken, lines.)

In *Fig.* 4 A we see how the two facets on the buccal side of the cusp are produced; by this cusp sliding down laterally between the two buccal cusps of the corresponding upper second molar. I have also included in this diagram the upper third and lower first molars, on which I have indicated the outlines of the resultant facets.

Now this movement, as the lower cusps slide down the grooves between the corresponding upper ones, corresponds to rotation of the mandible about a point within the condyle of the same side; which we may call the ipsilateral condyle. As pointed out by McLean (1938), this can be demonstrated by placing a pair of dividers with one point in the condylar fossa, when its other point can be made accurately to follow the paths of the cusps of the lower molars, along the grooves of the upper teeth, during chewing. I have called this the buccal phase of occlusion.

There is, however, a facet on the lingual face of this distobuccal cusp of the lower molar. This is indicated by shading with broken lines. On it the scratch marks run anterolingually rather than directly lingually; in fact in the same direction as the broken lines which form the shading. This facet is produced by the cusp shearing against the mesiolingual cusp, or protocone, of the corresponding upper molar, when the mandible rotates about the opposite, or contralateral, condyle. The manner of production of this facet is shown in *Fig.* 4 C. I have called this part of the chewing action the lingual phase of occlusion, and again the principle can be demonstrated by means of a pair of dividers.

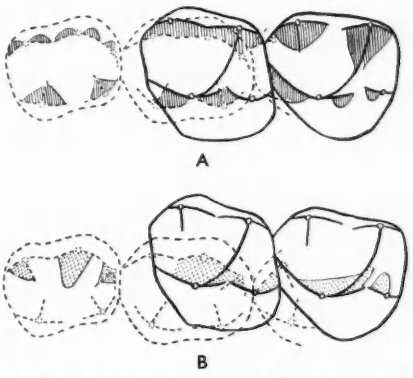

Fig. 5.—The upper and lower second molars of the *Gorilla*, superimposed; A, During the buccal phase of occlusion, and B, During the lingual phase, to show the areas of shear between the various cusps. The resulting facets are shown on the lower first and upper third molars.

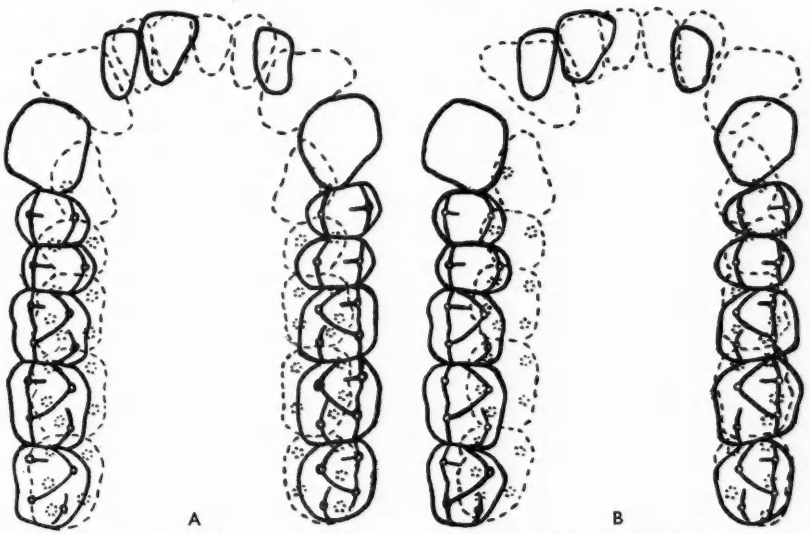

Fig. 6.—Plan view of the complete upper and lower dental arches of *Gorilla*, superimposed; A, In centric relation, and B, At the end of lateral excursion to the right.

If we now examine *Fig.* 5 we shall see that all the facets shown in *Fig.* 3 are accounted for by one of these two movements. All those

which I have represented by continuous line shading, and on which the scratch marks run almost directly transversely, are produced by rotation about the ipsilateral condyle,

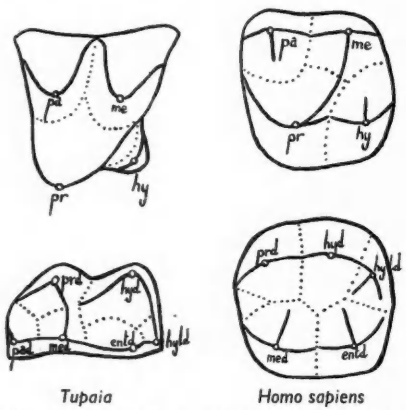

Fig. 7.—Upper and lower first molars of *Tupaia*, compared with those of man, to illustrate the nomenclature of the cusps.

as shown in *Fig.* 5 A. All those represented by shading with broken lines, and on which the scratch marks run somewhat anterolingually, are produced by rotation about the contralateral condyle, as in *Fig.* 5 B. I have been completely unable to find any facets which did not fit into one or other of these pictures, and, in fact, movement in any other direction is virtually impossible, because of the large canines.

Fig. 6 has been produced by first making accurate scale drawings of upper and lower dental arches of the gorilla. These have then been superimposed, on the left in centric relation, and on the right in right lateral excursion; that is, after rotation of the mandible about a point within the right condyle. The outlines of the lower teeth are shown by means of a broken, and the upper teeth by a continuous, line. It will be seen that in the centric position each cusp rests in a groove or fossa in the opposing tooth. In lateral excursion, the lower cusps on the ipsilateral side have moved down the grooves between the corresponding upper cusps, producing a scissors-like, cusp-in-groove shear.

This would serve to cut up the more fibrous articles of the diet—leaves and fruit, perhaps. On the contralateral side we have my "lingual phase" of occlusion taking place, and consequently producing a balanced occlusion. The mechanism is, however, rather different. The cusps of the lower teeth, instead of sliding between two upper ones, now move so that the plane lingual face of the lower buccal cusp shears against the buccal face of the upper lingual cusp. This produces a more horizontal type of shear, rather like a millstone, and perhaps intended for crushing and pulverizing the more brittle items of the diet, such as the bodies of insects.

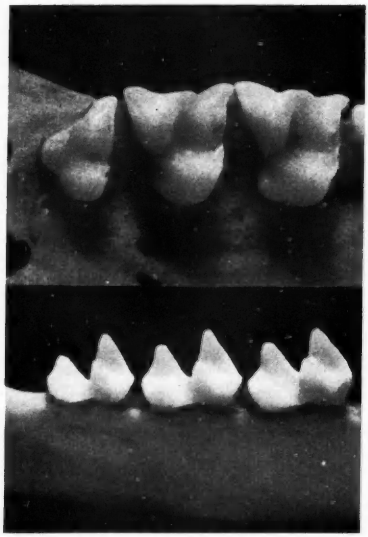

Fig. 8.—Oblique view of the upper and lower molar teeth of *Tupaia* seen from a position lingually and above the occlusal surfaces.

To summarize, therefore, we have two phases of occlusion, the buccal, corresponding to rotation of the mandible about a point within the ipsilateral condyle, passing through the centric position, into the lingual phase, which corresponds to rotation about a point within the contralateral condyle. Moreover, the two phases take place simultaneously on opposite sides of the mouth, producing a balancing occlusion.

So much, then, for the gorilla, an advanced primate, whose large size makes it relatively easy to examine, but which should, more properly, lie at the end of our story. Let us now turn our attention to the other end of the scale, to the most primitive of the Primates, the tree-shrew, *Tupaia*.

This is a small, somewhat squirrel-like animal, found in the jungles of the Malayan archipelago. Its position is not above controversy, since many authors class it among the insectivores. However, even these agree that it is closely related to the Primates, Gregory (1934, b) describing this family as a " 'living fossil' group surviving from the Paleocene and Lower Eocene, which reveals to us the initial stage in the adaptations of the Primates". Simpson (1945) places it firmly in the Primate order.

Its molar teeth are particularly interesting, since they represent a persistence of an early stage in the development of all modern mammalian teeth—the so-called dilambdodont stage. Each upper molar consists essentially of a simple triangle or trigon. There is a single large lingual cusp, corresponding to the mesiolingual cusp in man, and known in the terminology of Osborn (1888) as the protocone. This can be seen in *Figs.* 7, 8. About half way to the buccal margin are two further cusps, the paracone and metacone, corresponding to the mesiobuccal and distobuccal cusps in man. On the extreme buccal edge are three small cusps, or 'styles', which have no counterpart in the human dentition. They are joined to the paracone and metacone by a W-shaped series of ridges. At the base of the trigon, at a considerably lower level than these three cusps, and on the posterolingual face, is a very small cusp. This is called the hypocone, and develops to form the distolingual cusp in man.

The lower molars have two distinct parts. There is a high trigonid, rather similar to the trigon of the upper molars, but reversed buccolingually. There is also a lower heel, or talonid. The trigonid carries three cusps; buccally is the protoconid. which corresponds to our mesiobuccal cusp. Lingually it has two cusps; the paraconid, which has disappeared in the human dentition, is the more anterior, while posteriorly the metaconid corresponds to our mesiolingual cusp. There are also three cusps on the talonid; the hypoconid buccally, and the entoconid and hypoconulid lingually. These correspond to the distobuccal, distolingual, and distal cusps respectively in man.

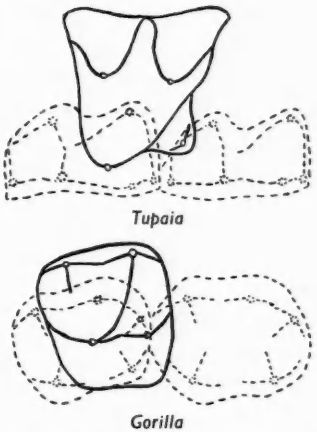

Fig. 9.—The upper first molar of *Tupaia* shown in centric occlusion with the first and second lower molars. A similar picture of *Gorilla* is shown for comparison.

It will be noted that the last of these has migrated from a lingual position in *Tupaia* to a buccal one in man. The above is essentially a description of the first upper and lower molars, but the remaining two differ only in details. The upper and lower dental arches are seen in plan view in *Fig.* 10.

In occlusion we have essentially the arrangement of reversed triangles which is the basis of the primitive mammalian dentition, as shown in *Fig.* 11. The upper trigon fits between the two lower trigonids, and occludes with the lower talonid. Thus the protocone fits into the centre of the talonid basin, and the hypoconid into the centre of the trigon, between the paracone and metacone. This is a very basic mammalian arrangement which is also seen in our own occlusion: indeed, in some ways it is a better criterion of normality than Angle's. In the same way, the trigonid of the lower molar fits between two upper

trigons, although in this case there is nothing corresponding to the talonid of the lower tooth, with which it can occlude; the hypocone is too rudimentary to be of much importance at this stage.

Most authorities consider that chewing, here again, consists of a vertical champing

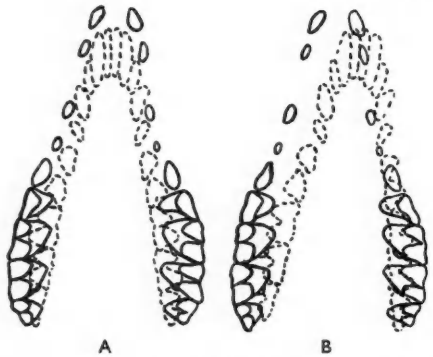

Fig. 10.—Upper and lower dental arches of *Tupaia*, superimposed; A, In centric relation; B, At the end of lateral excursion to the right.

action, but this is not strictly so. In fact, the basic principle is the same as that seen in the gorilla. During rotation about the ipsilateral condyle, the lower cusps pass between the corresponding upper ones, as seen on the right side in *Fig.* 10 B. At the same time, on the other side of the mouth, the lower buccal cusps are shearing across the upper lingual ones, rotation being about the contralateral condyle. This also produces a series of facets, as shown in *Fig.* 11. In *Fig.* 11 A we see the upper right second and third molars, shown by a continuous outline, and the lower first and second by a broken outline. The areas of contact between the teeth, during the buccal phase of occlusion, are shown by the continuous shading on the second molars, while the resulting facets are shown on the upper third and lower first molars. In the same way we can follow the production of the facets during the lingual phase of occlusion—that is, during rotation about the opposite condyle—in *Fig.* 11 B. It will be seen from the second molar occlusion that a very slight contact is produced by shear of the lower protoconid across the diminutive hypocone. The resultant facets cannot be clearly shown, since there is no hypocone on the third upper molar, while the protoconid of the first lower molar is functionless during the lingual phase of occlusion; it cannot shear across the hypocone

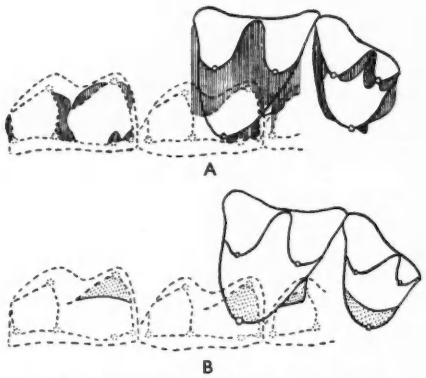

Fig. 11.—The upper and lower second molars of *Tupaia*, superimposed; A, During the buccal phase of occlusion; B, During the lingual phase, to show the areas of shear between the various cusps. The resulting facets are shown on the lower first and upper third molars.

of a premolar, since such a cusp does not exist in this genus.

So here again we have the two phases of occlusion, corresponding to rotation about the two opposite condyles. Again they occur on the two sides simultaneously, producing a balancing occlusion, as shown in *Fig.* 10 B. In fact, the picture is essentially similar to that seen in the much more advanced gorilla. Since the cusps of *Tupaia* are much sharper than those of *Gorilla*, the path of movement of the cusps is very steep in *Tupaia*, and nearly horizontal in *Gorilla*, but this is a difference of degree only, and not of principle.

I have examined and made detailed drawings of representatives of every family and subfamily of the Primates, with the exception of *Daubentonia*—the aye-aye of Madagascar—in which the dentition is highly specialized and the molars degenerate. I have also made less detailed examination of every genus represented in the British Museum (Natural

History) to eliminate the possibility of aberrant genera.

In general we find the same picture as in *Tupaia* and *Gorilla*; that is, of two phases of occlusion, the one corresponding to rotation about the condyle of the same side, and the other corresponding to rotation about the large, functional cusp, still shearing against the protoconid of the succeeding lower tooth, during the lingual phase of occlusion, and also shearing, to a slight extent, against the posterobuccal face of the entoconid during the buccal phase. Both the paraconid and hypoconulid have disappeared completely, and the trigonid

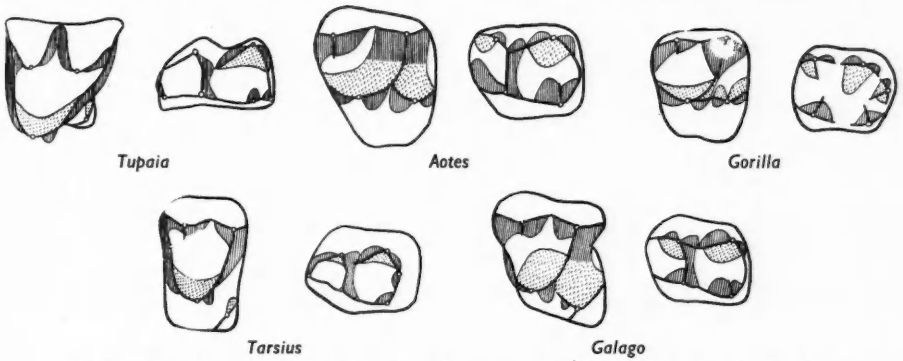

Fig. 12.—Plan of upper and lower first molars of representative genera of Primates, showing the pattern of wear facets found on these teeth.

opposite condyle. Moreover, there is a balanced occlusion in each case. Consequently, as one would expect, the facet pattern is essentially the same in each case. I have shown this in *Fig.* 12, for certain representative genera, *Tupaia*, with which we have already dealt, is the most primitive of all the primates. *Tarsius*, the spectal tarsier of Borneo, is the sole survivor of a group of Primates which is allied to the lemurs, and which was widespread in the Eocene era. The molars are slightly advanced beyond those of *Tupaia*, with the cusps considerably blunter. The external row of 'styles' is virtually eliminated on the upper molars, while the hypocone is somewhat larger, and shears against the protoconid of the lower molar during the lingual phase of occlusion. On the lower molar the paraconid and hypoconulid have both migrated somewhat buccally, while the trigonid is less raised above the talonid. The facet pattern, however, remains essentially the same.

Galago, the bush baby of East and West Africa, is a true lemur. It shows considerable advances over the condition seen in the tarsier. The hypocone has become a very of the lower molar is only slightly raised above the talonid. *Aotes* is a member of the New World monkeys, found in Central and South America. The picture is essentially the same as that seen in *Galago*, with a large hypocone producing a quadricuspid upper molar, and functioning primarily during the lingual phase of occlusion. However, a new facet has appeared on its posterolingual face, corresponding to one on the anterobuccal of the metaconid of the next succeeding lower molar, and produced during the buccal phase of occlusion. So this cusp now comes to play an important part in both phases of occlusion.

Finally we come to the picture seen in *Gorilla*, which I have already described. The main difference here is that we once again encounter the hypoconulid, which was absent in *Galago* and *Aotes*. It will be observed that the general pattern of the facets remains remarkably constant in all these widely differing members of the primate order, as, consequently, does the pattern of occlusion. This is not, of course, a phylogenetic series; all these genera are still in existence, although this pattern of facets has been identified in a

limited amount of fossil material. Nevertheless, they represent stages through which it is believed that man himself went, during his evolution.

I have not, so far, mentioned the Old World monkeys, from Asia and Africa; the ordinary monkeys, seen in large numbers in zoological gardens, and of which one member, the macaque, is a popular experimental animal. Here we find a slight difference from that seen in the other primates. The buccal phase of occlusion differs but little from that seen already, with the cusps of the lower molars passing in the grooves between the cusps of the upper molars. The only way in which the Old World mokeys differ from the majority of Primates during this phase of occlusion is in the increased importance of the lingual cusps. In the majority of families the lingual cusps of the lower molars are considerably lower than are the buccal ones. This means that in the buccal phase of occlusion contact of the lingual cusps is lost considerably before that of the buccal cusps. This is shown in *Fig.* 13, on the right side of diagram, for *Tupaia*. In the case of the Old World monkeys, on the other hand, the height of the lingual cusps is considerably increased, relative to the buccal ones, so that contact of the former is continued until the end of the buccal phase. This is again shown in *Fig.* 13, and, of course, considerably increases the efficiency of the mechanism.

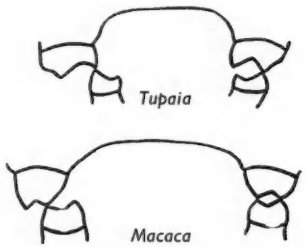

Fig. 13.—Cross-section through the centre of the first molars of *Tupaia* and *Macaca*, at the end of lateral excursion to the right.

There is a rather more noticeable difference during the lingual phase of occlusion. Firstly the importance of this phase of occlusion is greatly reduced, and contact between the upper lingual and lower buccal cusps quickly lost, so that there is no proper balancing occlusion. Secondly the upper lingual cusps are displaced anteriorly, and the lower buccal ones posteriorly. The result of this can be seen in *Fig.* 14. In the gorilla we see the cuspal arrangement usual in the Primates during the lingual phase of occlusion. The lower buccal cusp slides up the buccal face of the upper lingual cusp, with the millstone type of shear, and produces a single facet on each cusp. In the Old World monkeys, on the other hand, due to these cuspal displacements, the lower buccal cusps slide between the upper lingual ones, reproducing the effect seen during the buccal phase, and producing two facets on each cusp. This means that we have the cusp-in-groove, scissors-like, type of shear during both phases of occlusion. It is thought that this is a modification to suit a diet of leaves, and it is widely found among other leaf and grass-eaters, as diverse as the sheep, tapir, and kangaroo. It is, however, more or less unique among the Primates.

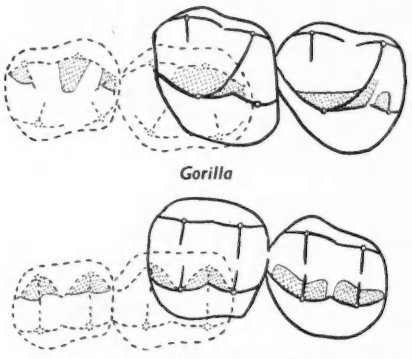

Fig. 14.—Upper and lower second molars of *Gorilla* and *Macaca* superimposed during the lingual phase of occlusion, to show the areas of shear between the cusps. The resultant facets are shown on the lower first and upper third molars.

It would seem, therefore, that in all the groups of Primates so far considered—that is, in all except man—the pattern of chewing is essentially the same, consisting of rotation of the mandible about the two condyles

alternately, with occlusion on the two sides of the mouth balancing. As previously indicated, the large canines of the gorilla prevent any intermediate movements since, if such were attempted, the cusps of the posterior teeth would be driven out of contact. The canines are similarly enlarged in the Old World monkeys and in some families of the New World monkeys. Among the Prosimii—the lemurs and tarsiers—the canines are little or no larger than the premolars. In these genera, however, the cusps are much sharper and more pointed than in the higher primates, and intermediate positions, which would produce a cusp-to-cusp relation during the buccal phase of occlusion, would be impracticable. Moreover, a careful scrutiny of the scratch marks on the molar teeth has failed to show any whose production could be accounted for by jaw movements in any other direction, although a large number are seen which result from this bilateral rotary movement. It may be noted that in the New World monkeys, large canines are in general found in those species whose cusps are relatively blunt, and small ones where the cusps are higher and sharper.

Now since this chewing mechanism is so universally found among the other primates, it would seem possible that it might also apply to man. The teeth of mammals generally are closely adapted to the mode of chewing, and there are only minor differences between the teeth of the gorilla and those of man. On the other hand, the canines in the permanent human dentition are reduced to the status of a third incisor, and are no longer interlocking (although they show a more ape-like arrangement in the deciduous dentition). Consequently, since the cusps are quite blunt, a range of intermediate movements is quite possible, and Gregory (1916) contrasts the lateral slide of the jaw in the gorilla with what he describes as a rotary movement in man.

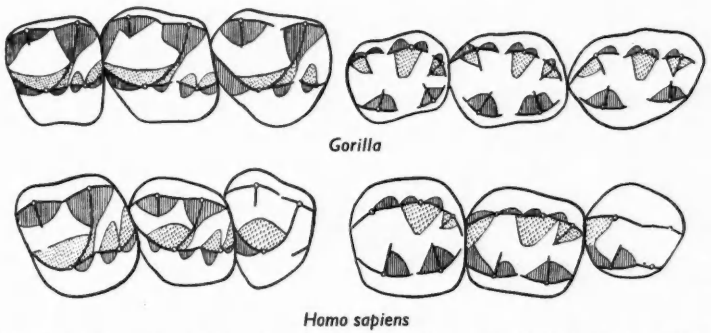

Fig. 15.—The pattern of wear facets found in the *Gorilla*, compared with those found on one human skull.

I do not altogether agree with this, but would suggest that the same pattern of chewing is normal for man as for the other primates.

It is surprisingly difficult to collect a number of human skulls which exhibit good occlusion, with a more or less full complement of teeth, and in which the cusps are not unduly worn. In the large collection of skulls in the Manchester Museum I was only able to find one. Consequently, my examination has been limited to five skulls, all of which exhibited normal occlusion, and such that the wear of the molar teeth had not exposed the dentine. There was no reason to think that their chewing action, during life, would have been in any way abnormal.

In these skulls the pattern of the wear facets is essentially the same as that seen in the gorilla, although it may not be possible to identify each separate facet in each specimen. In *Fig.* 15 we have the facet pattern for one skull, compared with that for the

gorilla. It will be seen that they are essentially alike, and that, here again, we have two sets of facets, one corresponding to rotation about the ipsilateral condyle and the other to rotation about the contralateral condyle. The scratch marks on the facets also show a high degree of parallelism nearly, if not quite, as marked as in the lower primates. It would seem, therefore, that the majority of wear is caused, and therefore the majority of chewing carried out, by this bicondylar rotary movement.

To digress slightly; I examined one skull which did not seem to fit into this picture. On two of the teeth, both premolars, were well-marked facets bearing scratch-marks which ran in an anteroposterior direction. This was somewhat disturbing, since I had been at considerable pains to exclude the possibility of such jaw movements in other primates. Bennejeant (1936) claims that it occurs in the Old World monkeys, but a close scrutiny had failed to find any evidence of it. However, the solution proved to be that these two teeth had been fitted to the skull posthumously, to replace two which had been lost. The facets had been produced artificially, by filing the teeth to restore the occlusion.

This theory of occlusion, as told by the wear facets on the molar teeth, has a number of applications, particularly in palaeontology. The teeth being hard and indestructible, they are frequently the only part of a fossil species which is known to us. From an examination of the cusp forms and the wear facets thereon it is possible not only to reconstruct the form of the opposing teeth, but also to tell some of the habits of the animal concerned and its relationship to other fossil or living forms.

It also has certain applications to the human dentition, and in particular it helps to explain the purpose of the eminentia articularis.

The articular eminence is, as Gregory and Hellman (1940) point out, a peculiarly human character, found only in man and the South African fossil ape-men or Australopithecines. In the great apes, however, the corresponding area of the articular fossa slopes downwards anteriorly, to the root of the zygoma. The human ementia is apparently an extension of this arrangement. In the monkeys and lemurs on the other hand, the anterior part of the glenoid fossa is more or less parallel to the occlusal plane; in the *Galagos* or bush-babies it even slopes upwards anteriorly.

The above authors consider that the purpose of the eminentia is to allow the incisors to "clear" their opponents during lateral movements, while many odontologists consider that it is a device to allow the incisor teeth to be used independently of the chewing teeth, in a manner analogous to that seen in the rodents. Indeed Reisner (1938) attempts to correlate the steepness of the slope of the eminentia with the degree of overbite. Neither of these arguments is convincing, for three reasons:—

1. In transferring the function from the molars to the incisors, the same effect could be produced by a horizontal forward translation, combined with a hinge-like opening movement of the mandible.

2. During lateral movement in an animal such as the gorilla, which normally has an edge-to-edge occlusion of the incisors, the teeth lose contact and open quite widely; the same is also true of the human dentition if an edge-to-edge relation of the incisors is present. This is, of course, due to the height of the cusps, which causes the so-called lateral movement to be, in fact, a lateral and downwards movement. Consequently there would be sufficient space to accommodate a normal degree of overbite of the incisor teeth.

3. Both the explanations so far advanced depend upon the positive overbite which is often present in man, and seldom so in other primates. But Hellman (1920) points out that this is essentially a development of the last 1,000 years, while the articular eminence has been present ever since the human line began to differentiate. Moreover the same author (1918) has shown that a positive overbite is present in about 30 per cent of orang outangs, where there is no articular eminence.

Let us now consider what happens during lateral excursion. The mandible rotates about a point within one condyle, while the other condyle moves forwards and downwards on to the eminentia. That is, the one condyle descends to a lower level than the other. This must produce a lateral tilting of the

mandible. Moreover it is difficult to see how this could be produced by any other means; it is difficult to visualize an efficient joint in which the articular surfaces part company.

Now if we examine the human molar teeth, it is noticeable that the upper molars lean somewhat buccally and the lowers lingually. This is different from the situation seen in all other primates; in the great apes they are approximately vertical, while in the lower primates the upper molars lean lingually and the lowers buccally.

The result of this can be seen in *Fig.* 16. This was prepared by selecting specimens of the genera *Lemur*, *Gorilla*, and *Homo* which exhibited good unworn dentitions. I then took impressions of their upper and lower dental arches, in a hydrocolloid impression material, and prepared models in stone-hard plaster-of-Paris. The lower model was carefully sectioned at the level of the hypoconid of the lower first permanent molar, using an orthodontic model-trimmer. The casts were then articulated in centric relation, and the upper model sectioned at the same level. Accurate photographs were then taken of the cut surfaces, and the line drawings shown in *Fig.* 16 produced by tracing from these photographs. It is important to realize that, whereas this section goes through the tip of the upper lingual cusp, on the buccal side it goes not through a cusp, but directly through the deepest part of the groove between the two buccal cusps. Similarly in the lower jaw, it goes through the tip of the buccal cusp, but through the lingual groove.

On the left side, in this figure, the upper and lower first molars of the three genera are therefore seen in centric relation. On the right they are shown in right lateral excursion, seen from behind, so that the teeth on the right of the diagram are in the buccal phase of occlusion, the tip of the hypoconid of the lower tooth having just completed its movement down the groove between the two upper buccal cusps. Those on the opposite side of the mouth are similarly at the end of the lingual phase of occlusion. Since this consists of a cusp-to-cusp shear, unlike the cusp-in-groove shear seen during the buccal phase, the tip of the hypoconid of the lower molar is resting on the tip of the protocone of the upper molar.

In the case of *Lemur* the tip of the protocone and the lowest point of the groove between paracone and metacone are at the same vertical level; they are both just touching the horizontal base line which I have drawn.

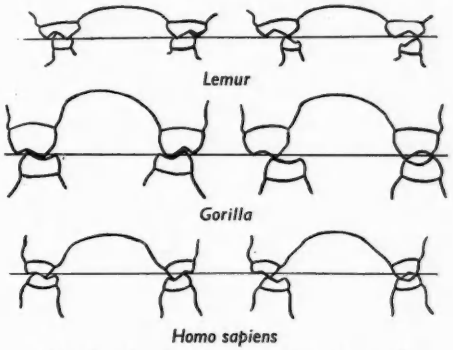

Fig. 16.—Cross-section through the first molars of *Lemur*, *Gorilla*, and *Homo sapiens*, at the level of the hypoconid of the lower first molar. Shown on the left in centric relation, and on the right at the end of lateral excursion to the right.

Therefore, as the tip of the hypoconid moves down the groove between the two buccal cusps on the right side of the mouth, so the tip of the same cusp on the opposite side of the mouth follows a parallel course down the buccal face of the protocone of the upper tooth. They finish at the same level and no tilting of the mandible is necessary.

In the case of the gorilla, on the other hand, the tip of the protocone hangs below the base line, which joins the lowest point of the buccal groove on each side. In lateral excursion to the right, therefore, as the hypoconid of the right lower molar moves down this groove, the same cusp of the tooth on the opposite side of the mouth has to move down to the tip of the protocone of the upper molar; that is, to a lower level than its fellow of the opposite side. To facilitate this the mandible has to tilt, and the anterior part of the glenoid fossa therefore slopes downwards to the root of the zygoma. This effect is even more marked in man, and to achieve the requisite degree of tilt an eminentia articularis becomes necessary.

To some extent the above is a statement of the obvious; if there is tilting of the mandible due to the condylar arrangement, and the teeth are to remain in contact bilaterally, the latter must be arranged in the manner which I have described. On the other hand, the converse is also true. I have not shown if there is a cause-and-effect relation, nor, if so, in which direction it operates.

Now in the case of man, with the jaws drawn back under the cranium, the mandibular base lies well outside the base of the maxillary arch, since the condyles are displaced relatively laterally. As a result the upper molars must lean outwards and the lowers inwards if they are to occlude. The condition in the gorilla is intermediate between these two extremes. In man, therefore, the tip of the protocone is considerably lower than the lowest point of the sulcus between the two buccal cusps. If the teeth are to remain in contact during lateral excursion, the mandible must tilt, and an eminentia articularis becomes necessary.

Fig. 17.—Bases of skulls of *Lemur*, *Gorilla*, and *Homo sapiens* reduced to the same width, to illustrate the gradual reduction of facial prognathism.

Fig. 17 shows the bases of the skulls of the same three animals—*Lemur*, *Gorilla*, and man. It will be observed that in the lemur the condylar fossæ lie almost directly behind the molar teeth, and considerably posterior to them. In the gorilla there is a considerable reduction in facial prognathism, and consequently the fossæ are displaced laterally relative to the teeth, while the latter are, of course, nearer to the condyles. In man, again, this effect is further accentuated. Consequently the tapering mandible of *Lemur* lies well within the upper arch, and if the molar teeth are to occlude, the upper ones must lean lingually and the lower ones buccally. As a result, the tips of the upper buccal cusps lie at a lower level than those of the lingual cusps. The reverse is true in the lower arch.

SUMMARY AND CONCLUSIONS

1. There is a common pattern of chewing throughout the Primates, including man.

2. This consists essentially of two phases. The one, corresponding to rotation of the mandible about a point within the condyle of the same side, is here called the buccal phase. In it the lower buccal cusps slide in the grooves between the upper buccal ones, and similarly the lower lingual cusps slide between the upper lingual ones.

3. This passes through the centric position, into the lingual phase of occlusion, which corresponds to rotation about a point within the opposite condyle. Here the lower buccal cusps normally slide down the buccal face of the upper lingual cusps, although there are differences of detail in the Old World monkeys.

4. The two phases of occlusion occur simultaneously on opposite sides of the mouth, thus producing a balanced occlusion.

5. In man, owing to the narrowness of the upper dental base compared with the lower, the upper molars lean buccally and the lowers lingually. This is the reverse of the situation seen among the lower Primates. In order that the teeth on both sides of the mouth shall remain in contact during lateral excursion, it is necessary for the mandible to tilt laterally.

6. The eminentia articularis is a device to enable this to take place.

Acknowledgements.—I wish to express my thanks to Professors H. G. Radden and E. Matthews for the facilities they have given me, and for their encouragement and advice. To Dr. T. C. S. Morrison-Scott and his colleagues at the British Museum (Natural History) for access to, and loans of specimens, particularly that shown in *Fig.* 9. To Mr. R. U. Sayce and his colleagues of the Manchester Museum, again for the loan of specimens, especially those shown in *Figs.* 1, 2, and 18. And to the Department of Medical Illustration, United Manchester Hospitals, for the preparation of photographs and lantern slides.

I would particularly thank Dr. P. M. Butler, of Manchester University, for his constant assistance and advice.

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DISCUSSION

Mr. Chapman, from the chair, thanked Mr. Mills for his paper and noticed that he had quoted from D. M. Shaw, who had been attached to the Royal Dental Hospital, but thought that not many of the meeting would remember him. He wrote a number of articles prior to the first world war, including "The Bearing of a Theory of Maximum Shear on the Mechanism of Mastication in Man" (1915) *Dent. Cosmos*, **57**, 465. He thought he had read a communication to the B.S.S.O. He was sure that Shaw would have been pleased to hear his work referred to. Mr. Chapman mentioned some of the classical theories concerning the articular eminence and the overbite. He felt that students of to-day were missing something in not having to learn the amount of comparative dental anatomy that was taught fifty years ago.

Dr. Burston in opening the discussion said that he was sure that the audience had all listened with great interest to this elegant analysis of the functional adaptations existing in the masticatory apparatus of the Primates. He for one, greatly welcomed this return to the morphological method, which he felt had, with a few notable exceptions, been relatively neglected during the last decade. He suggested that orthodontists had perhaps been somewhat overconcerned with *ad hoc* investigations aimed at the solution of some particular clinical problem. In their desire to produce diagnostic criteria for the appraisal of such problems they had introduced their own peculiar nomenclature and in an attempt to invest these qualitative terms with precise meaning, had often indulged in a host of geometrical and mathematical abstractions, mostly in the guise of cephalometrics.

Whatever the ultimate value of this approach might be, he felt that in the present state of knowledge it is unlikely to take us very far in the appreciation of the skull and masticatory apparatus as a functional, co-ordinated unit at all stages of development. So very little is known of the vital processes operating at the cellular level, of why a bone grows to a certain size and shape, or why a tooth assumes a certain form, of how a muscle functions or how the neural system operates, that it seems almost presumptuous to contain these mysteries within a mathematical formula based on a few arbitrary measurements and even the most refined methods known to physiology appear crude when considered in relation to this problem. The morphological approach seeks rather to find functional correlations existing in a living organism and here he used the word "functional" in its widest connotation as including all the vital processes taking place in the body, the integration of which leads to form as we know it. It does not presume to explain such findings in terms of final causes—rather does it use teleology as a regulative

principle. The interplay of form and functional adaptation is a problem that has excited the interest of great thinkers down the ages and orthodontists were privileged, as perhaps few others, to witness the interplay of these factors in their daily work. It is this functional adaptiveness of parts which is, as he thought, at the real centre of the orthodontic problem. Such an approach has the authority of antiquity and it was therefore in the true Cuvevian tradition that he welcomed this contribution of Mr. Mills; another stone added to the cairn of morphological knowledge which will eventually lead, he felt, to a truer understanding and sympathy for that complex and beautifully integrated piece of architecture—the skull and masticatory apparatus.

Turning now to some of the detailed points raised in the paper, he was particularly interested in Mr. Mills's analysis of the buccal and lingual phases of occlusion and the two distinctive parts each had to play in efficient mastication.

The meticulous accuracy of his observations and the logical force of his arguments command acceptance in so far as they apply to those Primates exhibiting idealized occlusion and in which the mandibular movements are constrained by the limitations imposed by the large and interdigitating canines to a narrow path.

However in the extension of these principles to man, he thought that caution was necessary because there are not the limitations imposed by large canines. He was prepared to accept that in a young adult, having relatively unworn molars such is in fact the case—he recently witnessed a film of cine-radiography of the condyle which, in retrospect, appeared to support this contention. However he wondered whether this is always true in older patients exhibiting true cusp attrition. He was aware that it is now suggested that a conditioned muscular behaviour operates under the influence of a possibly inherited neurological pattern. On a broader level the concept of individual chewing habits has received certain acceptance. On the present evidence it would appear that the cusps dictate the chewing habits of man, but when these are worn or lost does the neuromuscular unit perpetuate this action? In disturbances to the occlusion, such as is produced by drifting of teeth following extraction, or more dramatic events leading to faulty tooth position such as trauma, it is remarkable how the muscle action adapts, in many cases, to the new environment. Is it not then possible that with occlusal wear in man, and with no large canines to restrict the chewing action, this increased freedom may lead to the adoption of movements other than the bicondylar rotation suggested? Marked occlusal wear is a feature of most primitive dentitions and even in civilized man cuspal attrition often proceeds to a marked degree. As against this, in recently edentulous patients the gothic arch tracing obtained in prosthetic procedures appears to support the principle of bicondylar rotation and lends strength to the view that this is indeed the fundamental pattern.

Further to the question of mandibular movement, he would be interested to learn whether Mr. Mills observed any lateral translation of both condyles in the Bennett movement. He did not incline to this possibility himself, but would be grateful for Mr. Mills's view on the matter.

He was also most interested in Mr. Mills's hypothesis with reference to the functional correlation proposed between the eminentia articularis and the lateral inclination of the buccal teeth. He recently had the opportunity of examining the skulls of different races and was impressed by the almost vertical inclination of the teeth in certain dark races. Unfortunately he was not then aware of the possibility of this correlation and did not pay particular attention to the height of the eminentia, but as far as he recollected the eminentia was normally developed. Perhaps Mr. Mills would care to comment on this matter.

Returning to this question of cusp-in-groove and cusp-to-cusp occlusion, he was interested in the exception to the general rule provided by the Old World monkeys, particularly in view of their specialized diet. Is one to see in this a further justification for the Darwinian theory of evolution? He knew that *in sensuo stricto* and, as a respectable scientist of this generation, one should accept but are we entirely happy? He often wondered!

Finally he rather understood Mr. Mills to place these Primates in some sort of sequence, as showing how these masticatory systems had evolved. He knew that Mr. Mills would not support this series as in any way a phylogenetic one, but he was interested in the order in which he placed them, having regard to the fact that some consider the higher primates as having a more advanced tooth form than that seen in man.

He thanked Mr. Mills for a most interesting and stimulating paper.

Mr. Glass asked Mr. Mills whether man's dentition was essentially more primitive than other primates? As man appeared to be the only mammal with contact points throughout upper and lower arches and considering the prevalence of interproximal caries, did he consider this continuity of contact points a retrograde step in our dental development, and what were his views on the introduction of artificial diastemata by extractions?

Professor Hallett thanked Mr. Mills for his excellent paper, which he had found most interesting. He said that he would like to ask Mr. Mills whether he had examined several specimens of each family in determining the attrition patterns, whether the often different canine length between the sexes had led to variations in faceting, and, finally, whether he had made any observations upon the deciduous dentitions?

Mr. Mills thanked Dr. Burston for his kind remarks about his paper. He wholeheartedly agreed with Dr. Burston's views on the importance of morphological, as opposed to statistical, research. The cusp nomenclature introduced by Osborn was, in nearly all ways, more convenient than that usually employed by the dental profession, but it seemed improbable, at this stage, that the profession could be persuaded to change its habits in this matter.

He had not investigated the effects of cusp attrition, but he felt that the normal pattern of chewing was the result of an inherent neuromuscular pattern. While this chewing action might be prevented in certain cases, notably by cuspal interference, there was a strong tendency to return to it as soon as this was possible. This was confirmed by the instinctive chewing motions seen in a child with a "locked bite", in a postural Class III malocclusion, when using articulating paper to trim the posterior bite plane on an orthodontic appliance.

He had been unable to find any evidence of any Bennett movement in the primates. In a few genera it was impossible, because of the shape of the glenoid fossæ. In the other genera he did not feel that his method was sufficiently accurate to eliminate the possibility altogether. It might be the result of individual variation.

While it was true that in some individuals, particularly among the more primitive races, the molars were approximately vertical, this meant that the upper buccal cusps were on the same level as the upper lingual ones, and the groove between the former, even at its lowest point, was still higher than the tip of the lingual cusp. It therefore did not invalidate his argument.

He realized that he had tended to interpret his series as though it were a phylogenetic one. This was not strictly justifiable, but there was evidence to show that man had, in his evolution, gone through stages in which his dentition was very similar to those seen in certain recent Primates.

In reply to Mr. Glass, he felt that it was an over-simplification to describe man's dentition as more primitive than that of the lower Primates. Many of the apparently primitive features of our dentition were, in fact, only secondarily so.

It was true that many mammalian genera had diastemas in their dentition, but these were invariably frank spaces, and where the teeth were in contact, a normal contact point existed. The "slack contact" was, he thought, unknown in natural dentition.

In reply to Professor Hallett, he had based his examinations of the dentitions on a number of specimens. He had not kept records of the exact numbers, but thought six would be the minimum for any genus. He had examined the deciduous teeth of some genera, as a matter of interest, and found the same general pattern as in the adults.

It was true that the canines were reduced in the female sex in some families, notably the apes. This was, however, a difference of degree only, and did not materially affect the picture.

He looked forward to seeing Professor Hallett's demonstration. He had found the wear facets very well marked in models of Australian aborigines, shown him by Professor Campbell of Adelaide.

Replying to Mr. Chapman, he thought the main objection to the classical theories concerning the articular eminence was that the overbite was a development of the last 1000 years, while the eminentia had been present for at least a million years.

INFLAMMATION OF THE LYMPHATICS OF THE FACE SECONDARY TO DENTAL INFECTION

By **D. A. DIXON**, F.D.S. R.C.S. Eng.

THE lymphatic nodes of the face, although small and inconstant, share with the rest of the lymphatic system a liability to become infected and inflamed. A knowledge of their anatomy and pathology is therefore of importance to a dentist in the diagnosis of inflammatory conditions of the mouth.

The anatomy of the lymphatic tissue of the face has received much attention in the French dental literature, but is not generally given in any detail in the standard English text-books of anatomy. The earliest mention of the lymphatic vessels of the face is by Cruickshank (1786). Princeteau (1899) and Poirier, Cuneo, and Delamere (1903) give excellent detailed descriptions, while in the German literature Küttner (1899) first describes and names the facial nodes. More recently a short description is given by Sicher (1949), and a comprehensive account is to be found in the excellent book on the lymphatic system in man by Rouvière (1930).

The lymph-nodes of the anterior part of the face or cheeks may be divided into three groups (*Fig.* 1). The superior group comprises malar, infra-orbital, and nasogenial nodes, each or all being only occasionally present. The middle group consists of the buccinator nodes, which may themselves be split into three groups by the relationship of the facial artery and vein. Finally the inferior maxillary group is situated beneath the skin on the external surface of the mandible, anterior to the border of the masseter muscle, and in close relation to the facial artery and vein. The inferior maxillary group is sometimes related to the submandibular nodes by an inframaxillary gland described by Buchbinder (1899). The infra-orbital, buccinator, and inferior maxillary nodes if present are positioned near the course of the anterior facial vein, and form a pathway of lymphatic drainage from the cheeks. There are many synonyms for these nodes, and in the French literature they are usually referred to as the genial nodes. The terms mandibular, supramandibular, anterior facial, and pre-masseteric are frequently given to the inferior maxillary node.

A connexion between the lymphatic vessels of the gums and those of the face is stated by

Rouvière (1930) to be rare. MacGregor (1936), in an investigation into the lymphatic system of the teeth and jaws of various animals, including cats, dogs, and monkeys, traced the lymphatic vessels from the teeth and deeper structures. It was shown that these vessels emerge from the mental foramen and foramina and states that a tuberculous infection of the facial node may occur. A case of adenitis of the infra-orbital node is given by Rateau (1923), while Wätzold (1927) reports a case of pre-auricular adenitis following an infection of the lids. Balogh (1950) found the pre-masseteric (inferior maxillary) node present in

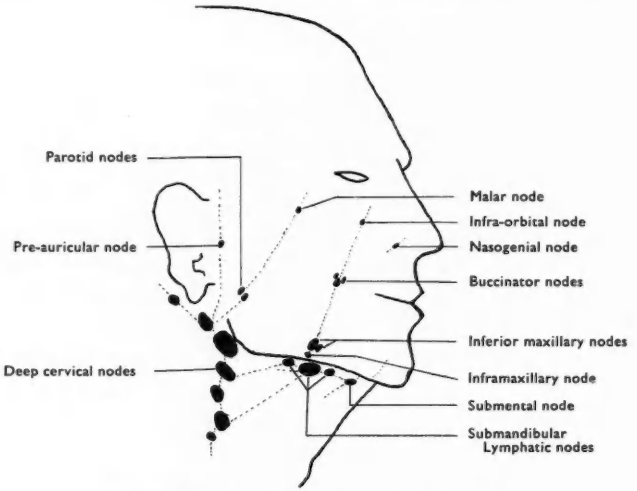

Fig. 1.—Arrangement of lymph-nodes of the face.

in the infra-orbital region and travel parallel with the anterior facial vessels to the submandibular nodes. Although these are the results of animal experimentation, it is probable that a similar arrangement is present in the human. If this is the case it is to be expected that the accessory lymph-nodes in the cheek will occasionally show inflammatory changes similar to those of the submandibular nodes in cases of dental infection.

Inflammatory conditions of the facial lymphatic system are uncommon. Montes (1905) describes a number of clinical cases, as does Thevenot (1900), the latter author together with Vigier (1892) giving credit to Professor Poncet for first calling attention to the condition. Richard (1927) considers the most constant cause of facial adenitis to be dental, oral, and tonsillar infections. He further cites an instance of a facial adenitis secondary to a syphilitic chancre of the lip, only two out of ten dissections and considers that adenitis of this node may originate from infection around the lower first molar or second premolar. Although the subject fairly often occurs in foreign literature, it has occasioned little interest in the English medical press. Hamilton Bailey (1930) reported a case of facial adenitis, but did not describe the origin of the infection.

Three cases will now be presented in which the clinical findings are consistent with a diagnosis of an inflammation of the facial lymphatic tissue secondary to dental infection.

CASE REPORTS

Case 1.—A male, aged 22 years, attended complaining of toothache and a swelling of the face (*Fig.* 2) which had been present for three days. Clinical examination revealed a localized fluctuant swelling in the left cheek, with both skin and mucosa freely movable over the area. An irregularity in the contour of the alveolus in the $\overline{6}$ region was present, and an X-ray revealed two buried and infected roots. There was no visible inflammation

of the adjacent oral mucosa. The patient was treated by extraction of the septic roots and external incision of the abscess. This contained some 2 c.c. of pus.

BACTERIOLOGICAL REPORT.—2 ml. greenish blood-flecked pus.

Film: Many pus cells, many Gram-positive cocci and Gram-negative bacilli, with a few Gram-positive bacilli.

Culture: Scanty hæmolytic streptococci, sensitive to penicillin. Also an anaerobic non-hæmolytic streptococcus sensitive to penicillin.

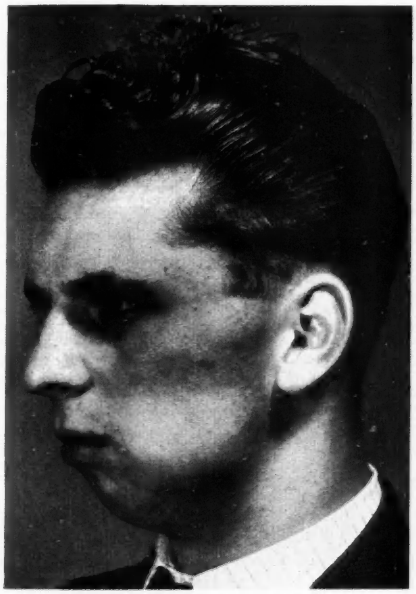

Fig. 2.—Lymphatic abscess of inferior maxillary node.

The patient stated that a small scar on the face in the region of the abscess was caused by the incision of a previous abscess some years previously. The case was diagnosed as a suppurative adenitis of the inferior maxillary node associated with dental infection.

Case 2.—A girl, aged 19 years, presented with a red fluctuant swelling in the cheek (*Fig.* 3). Both mucosa and skin were freely movable over the swelling. Two weeks previously $\overline{|6}$ had been extracted and three days later the swelling occurred. The socket was healing normally. A periostitic $\overline{|5}$ was present and on removing an amalgam filling from this tooth a necrotic pulp was found. The patient was treated by removal of $\overline{|5}$ and external incision of the abscess, which contained a small amount of pus.

BACTERIOLOGICAL REPORT.—

Film: Many pus cells. A few Gram-positive cocci. No acid-fast bacilli seen.

Culture: A moderate growth of an anaerobic non-hæmolytic streptococcus, insensitive to penicillin, sensitive to aureomycin.

A diagnosis was made of suppurative adenitis of the inferior maxillary node associated with dental infection.

Case 3.—A male, aged 38 years, attended complaining of a tender and swollen face (*Fig.* 4). Two days previously the tissues below the left orbital margin had become swollen, and on the following day a swelling at the level of the mandible appeared. Clinical examination revealed a tense œdematous swelling of the left infra-orbital region, and a tender firm palpable structure the size of

Fig. 3.—Lymphatic abscess of inferior maxillary node.

a small nut just above the border of the mandible and one inch lateral to the corner of the lip. Joining the two inflamed areas a tender cord-like structure could be palpated along the direction of the facial vessels, and a faint red line on the skin illustrated its course. Intra-oral examination revealed many bad teeth, with a periostitic $\underline{3|}$ and a discharging sinus in $\underline{5|}$ region. An X-ray showed the presence of a small infected cyst above the sinus. The acute symptoms were treated by extraction of the septic teeth and drainage of the cyst, and in two days the inflammatory process in the cheek had subsided completely. The case was diagnosed as lymphangitis of the face of dental origin.

DISCUSSION

The bacteriological findings in the first two cases are of interest. The anaerobic non-hæmolytic streptococcus is not a common organism, but may be found in the mouth,

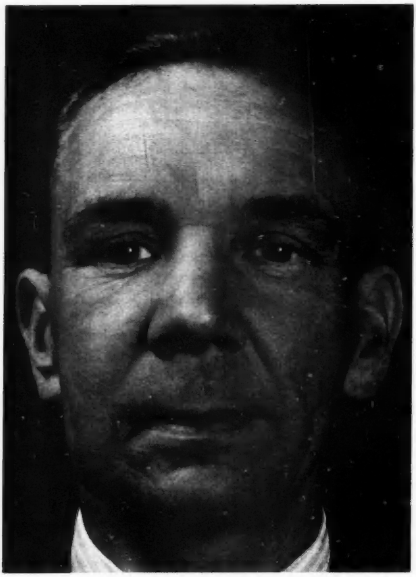

Fig. 4.—Lymphangitis of facial lymphatics with adenitis of inferior maxillary node.

sinuses, and other mucous cavities. It can be isolated in cases of dental sepsis and apical conditions (Med. Res. Council, 1929). Acute inflammation of the lymphatic vessels is generally caused by streptococci. In the cases reported the long-established nature of the dental sepsis may account for the presence of this organism and its possibly pathogenic role.

The diagnosis of this condition is of interest and importance. In the characteristic course of an infection of a lymphatic gland, the gland at first becomes tender to palpation, discrete, and freely movable in the tissues. Later a periadenitis develops and the gland becomes less mobile. After a period of days suppuration may occur, giving severe pain, a rise in temperature, leucocytosis, and further systemic symptoms. An infection of a lymphatic gland is likely to be of a recurrent nature, especially if the original cause is not removed, and this is illustrated by the first case.

A diagnosis of acute facial lymphadenitis may be made on the history of the infection, a bacteriological report to exclude tuberculous infection, and finally a consideration of the

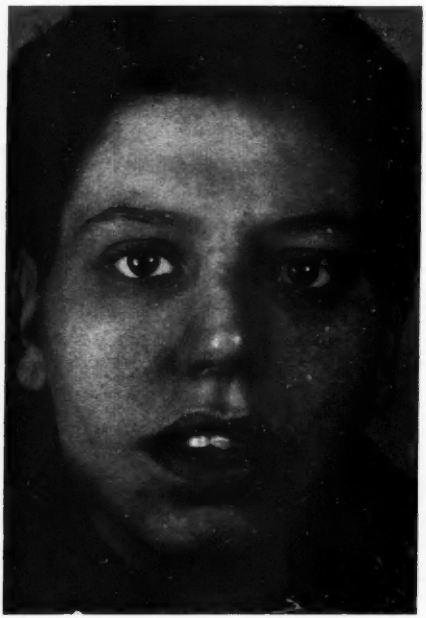

Fig. 5.—Alveolar abscess from second lower molar pointing externally.

clinical features of other conditions which may occur in the same region. A diagnostic feature of an acute lymphatic swelling of the cheek is that in the early stages it is not attached to skin or mucosa. Swellings which are similarly situated deep in the cheek substance may be either a lipoma formed from vestiges of the buccal pad of fat, or a cyst or adenoma of a molar gland. These conditions may be recognized by their slow growth and non-inflammatory nature. Superficial swellings caused by boils, stings, or a sebaceous cyst may be differentiated by their common movement with the skin. A general infection of the cheek substance may be caused by a thrombophlebitis of the anterior facial vein, the infection usually following trauma and showing a tendency to ascend the cheek in contrast to a lymphatic infection. If a case is of a chronic nature or fails to resolve with treatment, the possibility of a streptothrix infection must be considered.

The condition must be differentiated from an alveolar abscess, which may simulate a lymphatic abscess closely. An abscess arising from a lower molar tooth may track along the periosteal attachment of the buccinator muscle, and then extend around the anterior border of the muscle and point externally in the region of the inferior maxillary lymph-node (*Fig.* 5). Similarly an abscess from a lower premolar tooth may extend directly through the cheek, and occasionally infection from an upper molar, if perforating the bone above the buccinator muscle attachment, also points through the cheek. A sinus on or beneath the chin may arise from the lower incisors, and infection originating from an upper canine occasionally extends along the caninus muscle and may cause an abscess beneath the inner canthus of the eye. With an abscess arising by direct extension of infection from a tooth the vestibular sulcus is frequently inflamed, and if the abscess is incised it is often possible to demonstrate with sinus forceps the pathway of infection from the bone. After evaluating the clinical evidence of the first three of the cases reported it is considered that a diagnosis of inflammation of the lymphatic tissue of the face in these cases is justified.

SUMMARY

Three cases are reported in which it is considered that an inflammation of the facial lymphatic tissue has occurred secondary to infection of dental origin. A short discussion of the differential diagnosis is given, together with a description of relevant anatomy and pathology.

Acknowledgments.—I wish to thank Professor A. E. W. Miles and also Mr. A. G. Allen and Mr. S. G. Allen, Consultant Dental Surgeons to the London Hospital, for permission to publish the cases reported in this article.

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EXAMINATION RESULTS

UNIVERSITY OF LIVERPOOL

SEPTEMBER, 1955

Degree of B.D.S., First Examination. (b) Physics:—
Day, J. M.

Degree of B.D.S., Third Examination, Part II:—
Edmondson, Margaret N., McCracken, J. G., Roberts, Olive.

Licence in Dental Surgery, Third Examination, Part II:—
McAllister, D. H.

Degree of B.D.S., Final Examination, Part II:—
Brady, P., Thomas, D. N. L.

Licence in Dental Surgery, Final Examination, Part II:—
Ash, J. T., Brown, C. S., Crawford, A. C., Cunningham, Barbara, Gerrard, J. E., Goodman, B., Jones, S. P., Marray, J., Radam, E., Ramesar, J. D., Shaw, W. M., Turner, H. M., Warner, R.

THE PRE-EXTRACTION RECORDING OF THE VERTICAL DIMENSION BY AN INTRA-ORAL METHOD

By **A. J. W. TURRELL**, L.D.S.
Senior Lecturer in Dental Mechanics and Prosthetics, University of Sheffield

THE recording of the vertical dimension before it is lost irretrievably following the total extraction of the teeth by which it is maintained should be a routine procedure.

The methods for measuring this distance may be divided into extra-oral and intra-oral. In the extra-oral method the distance measured

Fig. 1.—A and B indicate two possible positions of applying the Willis' bite gauge. It is obvious that the difference in angulation will vary the nose-to-chin distance. The distance from the gauge to the chin is measured at C. (*See text.*)

is that from the nose to the chin, whereas in the intra-oral method the distance between two fixed dots, one in the maxilla and the other in the mandible, is recorded. The latter method is not well known in this country and was suggested by Meyer M. Silverman (1950).

The object of both methods is to obtain the same vertical relationship between the upper and lower alveolar processes when the dentures are clenched in centric occlusion as pertained when the natural teeth were present.

The extra-oral method is well known, the instrument being called a dakometer, but the Willis bite gauge, a simplified version, is used almost universally in this country because the dakometer is not so readily obtainable. It is claimed that the dakometer will measure the vertical dimension with an error range of ± 1 mm. (Fenn, Liddelow, and Gimson, 1953), but the Willis bite gauge, although possessing the virtue of simplicity, fails lamentably in accuracy. This inaccuracy arises because it is almost impossible to place the instrument on the face at the same angle and pressure repeatedly. Several different readings can be obtained by one operator when measuring the nose-to-chin distance of a patient before the teeth are extracted, and when, on arriving at the occlusion stage in the construction of dentures several months later, the gauge is set at the pre-extraction opening, there is no guarantee that it will be placed on the face at the same angle and pressure which produced that reading previous to the extractions. Admittedly, the error produced by wrong angulation can be reduced slightly by measuring the distance from the vertical arm to the chin and keeping this distance fixed for all measurements (*Fig.* 1), and the tissue displacement may be overcome in some cases by taking all measurements with no pressure, but when a labial flange is required to restore any lost contour of the upper lip its thickness will determine the forward projection of the upper lip, which in turn will influence the angulation of the gauge held against it. The lip may not be positioned exactly as it was when the original pre-extraction record was taken, for it depends upon the æsthetic sense of the operator.

Note: In this article the term "vertical dimension" is used to signify occlusal vertical relationship as opposed to rest vertical dimension.

It is possible to have an error of more than 5 mm., which cannot be accepted when one considers that the maximum interocclusal space is said to be in the region of 4 mm.

For these reasons the writer was attracted to the intra-oral method of Silverman, who injects a dot of indian ink into the epithelial tissue of the labial aspects of both the upper and lower alveolar processes by means of a specially adapted needle in a Luer syringe. The dots are placed in line with one another. He claims that the ink spots will show up beneath the healed tissues throughout life. The distance between the two dots is measured with dividers with the patient closed in centric occlusion.

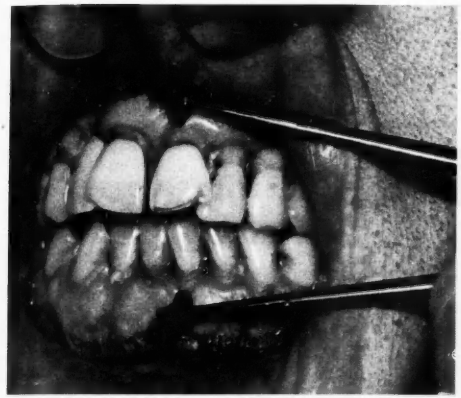

Fig. 2.—The interfrænal distance being measured with dividers.

Although permanency is an obvious advantage, many patients would not be willing to consent to what would seem to them rather drastic treatment in order to obtain a measurement, the importance of which many would find very difficult to appreciate even when the areas injected with ink are first anæsthetized.

The writer's suggestion overcomes this difficulty, and is based on the presence of two natural structures which are present in most mouths and which remain after the extractions —*the upper and lower labial frœna.* With an indelible pencil, dots are placed on the frœna at the lowest and highest points of attachment respectively to the labial walls of the maxilla and mandible. With the patient closed in centric occlusion the distance between the dots is measured with dividers (*Fig.* 2) and can be either scribed on the patient's record card or measured off in millimetres. At the occlusion stage dots are again placed on the points of attachment of the frœna and the lower block is adjusted until the original separation is reached, which is indicated by checking with the arms of the dividers set at the pre-extraction opening and placed on the two fixed points.

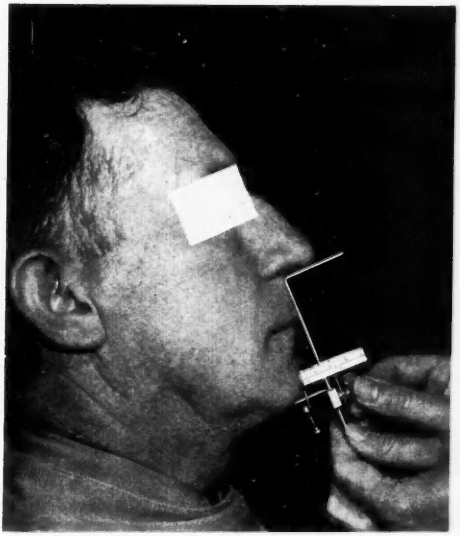

Fig. 3.—The Willis bite gauge is shown with the chin-attachment referred to in the text.

If the recess cut in the labial flanges of the occlusal blocks to relieve the frœna is adjusted with great care to the pencil dots, a further check can be made with the blocks stuck together outside the mouth. It is interesting to check the finished dentures in the same manner.

EXPERIMENTAL DATA

In order to demonstrate the inaccuracy of the Willis bite gauge, its slightly increased accuracy when a chin attachment is incorporated (*Fig.* 3), and the accuracy of the

interfrænal measurement, four operators, A, B, C, and D, were each in turn asked to take six measurements all on the same subject: (1) with the orthodox Willis' bite gauge; (2) with the gauge and a chin attachment designed by the writer; and (3) the interfrænal distance.

They were asked to take the first measurements (1) with or without pressure as they wished, but the series with the attachment (2) were taken without pressure. The distance from the chin to the vertical arm of the gauge was noted after the initial measurement had been taken by each operator, and the attachment was adjusted to that distance for all subsequent measurements.

Operators A, B, and C had some experience with the Willis bite gauge, but none with the chin attachment. Operator D had no experience with the gauge. All four operators had never previously taken the interfrænal distance.

After each adjustment of the gauge or dividers the operator handed the instrument to the writer, and was not permitted to see the figures arrived at until the whole series had been completed. In this way the operators

Operator A

		Measurements in Millimetres					
		1	2	3	4	5	6
Series 1: Bite gauge used without chin attachment (Pressure used)	First readings	82·0	81·0	84·0	80·5	80·0	80·0
	2 weeks later	78·0	76·0	79·0	78·5	80·0	77·0
	Difference	4·0	5·0	5·0	2·0	0·0	3·0
Series 2: Bite gauge used with chin attachment at 10·0 mm. (No pressure)	First readings	83·0	82·0	78·0	79·0	80·5	79·5
	2 weeks later	76·5	75·5	79·0	77·5	76·5	78·0
	Difference	6·5	6·5	1·0	1·5	4·0	1·5
Series 3: Interfrænal distance	First readings	30·0	30·0	30·0	30·0	30·0	30·0
	2 weeks later	30·5	30·0	30·5	29·0	30·0	30·0
	Difference	0·5	0·0	0·5	1·0	0·0	0·0

Operator B

		Measurements in Millimetres					
		1	2	3	4	5	6
Series 1: Bite gauge used without chin attachment (No pressure)	First readings	77·0	75·5	75·0	79·0	77·0	74·0
	2 weeks later	79·0	79·5	80·5	80·0	79·0	80·5
	Difference	2·0	4·0	5·5	1·0	2·0	6·5
Series 2: Bite gauge used with chin attachment at 11·5 mm. (No pressure)	First readings	77·5	79·5	79·5	79·0	79·0	76·5
	2 weeks later	78·5	77·0	78·5	78·0	77·0	77·0
	Difference	1·0	2·5	1·0	1·0	2·0	0·5
Series 3: Interfrænal distance	First readings	29·5	32·0	31·5	30·0	30·5	30·5
	2 weeks later	30·5	30·5	30·0	29·5	29·0	29·5
	Difference	1·0	1·5	1·5	0·5	1·5	1·0

were not influenced by any previous measurements.

The second group of readings was taken two weeks later from the same subject, and

Some of the figures obtained by the gauge are very poor whilst others are favourable, but one would expect a far greater inaccuracy when the gauge is used as intended—that is,

OPERATOR C

		Measurements in Millimetres					
		1	2	3	4	5	6
Series 1: Bite gauge used without chin attachment (Pressure used)	First readings	85·0	87·0	84·0	86·0	84·0	83·5
	2 weeks later	87·0	84·0	86·0	85·5	86·0	86·5
	Difference	2·0	3·0	2·0	0·5	2·0	3·0
Series 2: Bite gauge used with chin attachment at 11·0 mm. (No pressure)	First readings	78·0	79·0	80·0	79·0	80·0	79·0
	2 weeks later	82·5	80·0	80·0	79·5	80·0	80·0
	Difference	4·5	1·0	0·0	0·5	0·0	1·0
Series 3: Interfrænal distance	First readings	31·0	31·0	31·0	31·0	31·0	31·0
	2 weeks later	30·5	31·0	30·5	30·0	30·0	30·5
	Difference	0·5	0·0	0·5	1·0	1·0	0·5

OPERATOR D

		Measurements in Millimetres					
		1	2	3	4	5	6
Series 1: Bite gauge used without chin attachment (No pressure)	First readings	77·0	71·0	77·0	69·0	71·0	69·5
	2 weeks later	75·0	81·0	79·5	79·0	77·0	76·5
	Difference	2·0	10·0	2·5	10·0	6·0	7·0
Series 2: Bite gauge used with chin attachment at 19·0 mm. (No pressure)	First readings	66·5	67·5	69·5	77·0	71·0	71·5
	2 weeks later	74·5	78·0	75·5	76·5	74·5	75·0
	Difference	8·0	10·5	6·0	0·5	3·5	3·5
Series 3: Interfrænal distance	First readings	32·0	32·0	32·5	30·5	32·5	31·5
	2 weeks later	30·5	31·0	31·5	31·0	31·0	31·0
	Difference	1·5	1·0	1·0	0·5	1·5	0·5

the six readings grouped with those taken previously as shown in the tables, so as to indicate the differences in measurement.

Under these purely experimental conditions the writer considered that a greater degree of accuracy could be expected, for the vertical dimension was maintained by natural teeth and remained the same for all measurements taken by the four operators.

Some of the figures obtained by the gauge are very poor whilst others are favourable, but one would expect a far greater inaccuracy when the gauge is used as intended—that is, to measure the nose-to-chin distance before extractions, followed some time later, when the patient is edentulous, by the gauge being set at the pre-extraction figure and the lower block increased or decreased in depth till the nose-to-chin distance gives the same reading.

It will be noted that the interfrænal distance method is very accurate, and that

measurements arrived at by the four operators do not vary greatly.

Though the method suggested is perhaps not as accurate as the Silverman method, it is as simple to use as the Willis bite gauge and, the author feels convinced, far more accurate.

It is realized that the method is so simple that it may have been suggested before, but the author has failed to find it recorded in the literature.

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FENN, H. R. B., LIDDELOW, K. P., and GIMSON, A. P. (1953), *Clinical Dental Prosthetics*. London: Staples Press.

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ABSTRACTS FROM OTHER JOURNALS

An Evaluation of Cavity Preparation in Primary Molars

A standard technique was used to insert amalgam fillings into proximal-occlusal cavities cut in brass models of deciduous teeth. These fillings were then subjected to measured stresses until they fractured. Various types of cavity preparations were compared in this manner. It was concluded that certain additional refinements to Black's classical cavity form would increase the fracture strength of the amalgam fillings considerably. These refinements were:—

1. The isthmus between the keyway and the box should be approximately one-quarter of the width of the tooth.
2. The pulpal floor should be rounded.
3. Buccal axial and lingual axial side-retention grooves should be cut in the proximal box from the gingival wall occlusally to the dentine-enamel junction.
4. The pulpal axial line angle should be rounded.
5. A gingival retention groove should be added.

These additions increase fracture strength over forty times.—LAMPSHIRE, E. L. (1955), *J. dent. Child.*, **22**, No. 1, 3.

Splints and Bridgework Retained by Horizontal Pins

A method is described for making a splint device for the support of anterior teeth, e.g., those afflicted by periodontosis. The splint consists of a casting in precious metal which fits against the lingual surfaces of the teeth to be splinted. Threaded pins pass through both splint and teeth labiolingually, and pins and splint are secured to each other and to the teeth by means of cement.

The holes for the pins in the incisor teeth are sited axially, midway between the pulp and the incisal edge; those in the canines converge and tilt downwards lingually. By means of steel dummy pins, an impression is made in which can be located the incisor pins and dummy pins for the canines. The dummy canine pins are replaced in the investment model by iridio-platinum wire pins which each have a gold lock soldered to the lingual end. The splint is modelled in wax with these pins in position so that key holes are formed, but the pins are removed before casting. The incisor pins, which must be parallel, are incorporated in the casting.

The splint is cemented into position, the canine pins being inserted separately, from the lingual direction, after the splint bearing the incisor pins has been placed into position. The pins are then cut off on the labial side and polished flush with the surface of the teeth or they may be countersunk and the resulting depressions concealed with silicate or acrylic fillings.

Two cases are quoted in which splints fitted four years ago are still satisfactory.—KAY, S. (1954), *J. pros. Dent.*, 4, 656.

Deposit of Tartar on Dentures

In reply to "What is tartar?"—"Where does it come from?"—"What is the best way to prevent its deposition?"—and "Does its appearance depend on the *p*H of one's saliva?", the answer, under "Any Questions?", is as

follows: The deposit on the dentures is probably "tartar". The mode of deposition of this tartar or calculus is still undetermined, though much work has been done on it. The saliva contains a very high concentration of calcium and phosphorus, and their stability may depend on the colloids also present in the saliva. It has been postulated that the low tension of carbon dioxide in the mouth, with consequent loss of carbon dioxide from the saliva, causes precipitation of calcium salts. It is thought that the presence of carbon dioxide is important in maintaining a high concentration of calcium salts in the saliva. The *p*H of the saliva is very variable, largely depending on the carbon dioxide content, and there is no obvious correlation of figures for salivary *p*H and tartar deposition between one individual and another.

The tartar deposit tends to be greatest opposite the openings of the salivary ducts, and forms on the natural teeth and to some extent on dentures. There is at present no way of stopping this deposition and recourse must be had to its physical removal. Brushing the dentures each day with a soft brush and soap should keep them well polished and free of tartar, but if the surface of the dentures loses its polish, tartar deposits may be more marked. It would be as well, if the deposit continues, to get the dentures repolished, as this helps to prevent further deposition.—*Brit. med. J.*, 1955, **1**, 1249.

The Production of Erythema of the Skin by Exposure to X-ray Radiations

Previous references to the safe dose of X-rays to a skin area with a dental X-ray machine quoted a figure of 600 Ma. S., being half the erythema dose of 1200 Ma. S. This figure not to be exceeded in any period of 14 days. Experiments were carried out to discover the amount of radiation required to produce an erythema similar to sunburn on the flexor surface of the forearm of volunteers. A modern dental X-ray machine giving 65 KVP and 10 Ma. with inherent filtration approximately equal to 1 mm. of aluminium was used. There was no additional filtration and at the tip of the pointer cone 7½ in. from the focal spot the set delivered 165 r a minute in air. The half-value layer of radiation was 0·7 mm. aluminium.

An initial experiment was carried out, exposing an area 1⅛ in. diameter on the flexor surface of the forearm of 20 male volunteers of college age. The order of radiation required to produce an erythema was 425 Ma. S for the smallest dose up to 550–600 Ma. S for the majority.

A second experiment was planned to study the reaction in more detail; 19 additional male volunteers were used. The result was:—

540 Ma. S produced an erythema in 6 of 15 subjects (40 per cent).

600 Ma. S produced an erythema in 14 of 19 subjects (73·7 per cent).

660 Ma. S produced an erythema in 16 of 17 subjects (94·2 per cent).

100 r measured in air was found to be equivalent to a skin dose of 104 r with 1⅛ in. diameter beam and 109 r with a 4 in. beam. It was suggested, the face being less sensitive than the arm to radiations, that no one area of the face be exposed at 7½ in. target skin distance to more than 400 Ma. S in any 2 weeks bearing in mind that the 2-weeks period has no experimental basis.—Richards, Albert E. (1955), *J. dent. Res.*, **34**, 100.

Surveyors and Surveying

An easily reproducible surveying table is described, made up with the aid of a 1-in. steel ball-bearing and a plane surfaced plaster slab. Using a cutter of suitable curvature, a concavity ⅜ in. deep is cut in the surface of the slab and another in the base of the model to be surveyed. The ball-bearing is placed in the recess in the slab and heated until wax will run over its surface. While the wax is still soft the model is placed on the ball-bearing at the selected angle. If it is necessary to remove and replace the model at the specified tilt, the model and slab can be treated with a separating medium and plaster moulded between them. Surveying devices are described made from laboratory retort stands and from weighted pencils slung from a height above the bench.—Atkinson, H. F. (1955), *Aust. J. Dent.*, **59**, 28.

THE BRITISH SOCIETY OF PERIODONTOLOGY

Programme 1955–6

Monday, Oct. 3, 1955, at 5 p.m., Eastman Dental Hospital, Gray's Inn Road, W.C.1: Annual General Meeting; Presidential Address by W. G. Cross, M.S., M.B., B.D.S.

Monday, Nov. 7, 1955, at 5 p.m., Eastman Dental Hospital, Gray's Inn Road, W.C.1: "Periodontology in the General Dental Service", by D. W. Macfarlane, L.D.S. R.C.S.

Monday, Dec. 5, 1955, at 5 p.m., Eastman Dental Hospital, Gray's Inn Road, W.C.1: "Bridges—with Particular Relation to the Periodontal Tissues", by G. A. Morrant, B.D.S., L.D.S. R.C.S.

Monday, Feb. 6, 1956, at 5 p.m., Eastman Dental Hospital, Gray's Inn Road, W.C.1: "Bone", by J. A. Pedler, M.D.S., F.D.S. R.C.S., L.R.C.P., M.R.C.S.

Saturday, March 3, 1956, School of Dental Surgery, Edinburgh: "Masticatory Efficiency and Periodontal Disease", by J. W. Galloway, T.D., L.R.C.P., L.R.C.S., L.R.F.P.S., L.D.S. R.C.S.

Monday, April 9, 1956, at 5 p.m., Eastman Dental Hospital, Gray's Inn Road, W.C.1: "Salivary Gland Function", by A. C. Kerr, L.D.S. R.F.P.S.

Thursday and Friday, May 3 and 4, 1956, Eastman Dental Hospital, Gray's Inn Road, W.C.1: Course by Dr. Jens Waerhaug, of Oslo (*Special Fee*).

Friday, May 4, 1956, at 2 p.m., Eastman Dental Hospital, Gray's Inn Road, W.C.1: Annual Clinical Meeting. Dinner-Dance at the Criterion Restaurant.

THE NATIONAL HEALTH SERVICE IN 1954*

General Dental Services

The total of courses of dental treatment for which payment was claimed in 1954 was 7,441,903, which was close on 800,000 more than in 1953. In addition there was 1,895,365 claims for payment for emergency treatment (1,704,127) in 1953. The amount of fees authorized by the Dental Estimates Board and paid to dentists was £28,977,330. This included £6,816,935 paid by patients for dentures and treatment.

The amount of conservative treatment provided again increased, most markedly in respect of persons under 21. (Page 70.)

Altogether, over a quarter of all courses of treatment were for children. (Page 72.)

Dental Manpower.—The total number of dentists in the Service at the end of 1954 was 9,599, an increase of 126. This increase is mainly in assistants, about whom fuller information became available. (Page 74.)

* Report of the Ministry of Health for the year ended 31 December, 1954, Part I. Command 9566. H.M.S.O. Price 8s.

NEW DENTAL JOURNAL

THE American Dental Association has announced plans to publish a new monthly journal entitled *Dental Abstracts*. The first issue will appear in January, 1956.

The new publication will contain abstracts of articles drawn from all the important dental publications in the world. Periodicals of allied health professions will also be reviewed for articles of interest to dentists.

According to Dr. Lon W. Morrey, of Chicago, Editor-in-chief of publications, American Dental Association, *Dental Abstracts* will provide in a reading time of a few hours a survey of dental progress throughout the world. Although each abstract will be complete in itself and will give the reader the gist of the original paper, it cannot be as valuable as the original, to which the interested reader will have to refer for the complete text, illustrations, charts, tables, and bibliography.

The annual subscription price, outside of the United States, is $7 payable in advance in U.S. currency. Applications to: *Dental Abstracts*, American Dental Association, 222 East Superior Street, Chicago 11, Illinois, U.S.A.

CLACTON DENTIST'S HIGH COURT TAX CASE

A CLACTON dentist put up his practice for sale and a draft agreement was prepared which assigned the lease of the premises for £449 15s. and the furniture and equipment at valuation, no money being asked for goodwill. The purchaser had to borrow money from his bank in order to be able to complete the purchase but the bank manager insisted that a substantial sum should be allocated to goodwill before a loan could be granted. The agreement was therefore altered, a sum of £1450 being allocated to lease and goodwill, and £445 to furniture and equipment.

At the hearing before the General Commissioners of the Tendring Division, the purchasing dentist argued that the deduction of £1000 from the value of the furniture and equipment and its transfer to goodwill was merely a device to enable him to obtain a bank loan, and that it did not represent the true state of affairs. The true intention of both parties was indicated by the draft agreement. The goodwill of the practice was worth very little and he was entitled to claim capital allowances on £1445, that being the true value of the furniture and equipment as valued by a professional valuer.

The vending taxpayer argued that the final agreement was conclusive, the parties having come to a fresh arrangement. The sale price of the furniture and equipment should therefore be regarded as £445.

The Tendring Commissioners decided that they were entitled to look behind the terms of the final agreement in order to decide the intentions of the parties. They decided that they were not bound by the final agreement and they apportioned £1445 to furniture and equipment. The vending taxpayer appealed further against this decision.

In the High Court, Judge Wynn Parry said that in order to construe the final agreement, it was not permissible to take into account the original agreement. The Commissioners had the power to make an apportionment and they had properly addressed themselves to the proper question, but they had been wrong in going behind the terms of the agreement to decide the intentions of the parties. Their function was not necessarily to discover the intentions of the parties: it was to make a just apportionment. Having decided that they were not bound by the terms of the agreement, the Commissioners had gone on to make an apportionment.

The only question was whether there had been evidence of value on which to make the apportionment. There had, in fact, been a professional valuation of the furniture and equipment at £1445 and this was evidence of value. The Commissioners could not have reached any other decision. The appeal must be dismissed with costs. *Fitton* v. *Gilders and Heaton* (Inspector of Taxes) Chancery Division. (Wynn Parry, J.) July 13, 1955.

Footnote by our Tax Expert.—The true reason why this case was brought is scarcely referred to in the report of the proceedings. It all hinges on the question of capital allowances for tax purposes in respect of the furniture and equipment. If the value of the furniture and equipment was considered to be £445, this low figure would be to the advantage of the vending dentist in that the capital allowances already given him would probably not need to be reviewed, or if reviewed at all, then in his favour. On the other hand a figure of £445 would be to the disadvantage of the purchasing dentist, since he would only be able to claim capital allowances on that amount.

With the figure fixed at £1445, the purchasing dentist could claim capital allowances on this figure and the vending dentist would be assessed on the difference between the written-down value of the furniture and equipment as shown in his balance sheet last rendered to the Inland Revenue, and the sale price actually realized. This difference would be an assessable "profit". Hence the acute division of interest between the vendor and the purchaser, the tax inspector more or less sitting on the fence.

BOOK REVIEWS

A COMPREHENSIVE REVIEW OF DENTISTRY. For use in Preparing for State Board Licensing Examinations. Edited by VINCENT R. TRAPOZZANO, D.D.S., F.A.D.P., formerly Professor of Prosthetic Dentistry, Head of Prosthetic Department and Director of Postgraduate Division, Thomas W. Evans Museum and Dental Institute, School of Dentistry, University of Pennsylvania. With the collaboration of 24 contributors. $9\frac{1}{8} \times 6\frac{1}{8}$ in. Pp. 665 + xi. 1955. Philadelphia and London: W. B. Saunders Co. Ltd. 56s.

THIS book, written in the form of question and answer, and specifically for candidates for the American State Board Examinations, cannot be recommended for students in this country. Dr. Trapozzano points out in his preface that this technique of writing has proved successful in training "large numbers of men quickly and efficiently" but omits to mention that the men in question were left with no deep knowledge of their subject, only the "know-how" to perform routine tasks. However, as the U.S. Army has found the strip cartoon even more successful, we may look forward with renewed interest to the next edition of this book.

N. M.

OXYGEN INSUFFLATION IN PERIODONTAL DISEASES. By HAROLD K. BOX, D.D.S., Ph.D., F.D.S. R.C.S. Eng., Research Professor of Periodontology, Faculty of Dentistry, University of Toronto. $8\frac{1}{2} \times 5\frac{1}{2}$ in. Pp. 94+xi, with 61 illustrations. 1955. U.S.A.: Charles C. Thomas. 25s.

THIS short work is appropriately dedicated to the memory of William Fraser Dunlop who was the pioneer of oxygen insufflation in the treatment of periodontal diseases. Dr. Box has for many years been a firm believer in this form of treatment, and it is not surprising therefore that when approached by publishers he readily acceded to their request for a monograph. What is surprising, however, is that only one-third of this work is devoted to an explanation of the technique of oxygen insufflation, its place in case-management and a report of some animal experiments.

A book such as this must be considered to be primarily for the specialist and as after more than 40 years this form of therapy is still not widely practised, the reader might expect to find information and proof which will convince him of its value. Such evidence is not to be found. There are no photographs of cases before and after treatment. In the short chapter on the results of animal experiments it is claimed that tightening of the teeth of sheep was obtained. Measurements of tooth mobility apparently to an accuracy of 0·25 mm. are quoted, but the author makes no mention of the way in which he made such accurate recordings.

The first sixty pages of the book deal with the author's views and his classification of inflammatory types of periodontal diseases. There are many photomicrographs, some of which present interesting features capable of being interpreted in more than one way.

To summarize, this is a book in which the technique of oxygen insufflation therapy for periodontal diseases is described in such a way that anyone wishing to try this form of treatment will be able to do so, but that is the limit of the book's value.

The publishers have performed their task well, the book being clearly printed on good quality paper and free from typographical error. The binding is semi-soft, but entirely adequate for this size of book.

A. B. W.

CORRIGENDA

In the article on "Bite Analysis and Selective Grinding in Dental Practice", by J. R. Trott and A. Bryan Wade, the illustrations *Fig.* 8 C and E should be transposed with those of *Fig.* 9 F and D, respectively (September, 1955, No. 1, pp. 9, 10).